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A message to Maryland's citizens

The Maryland Department of Natural Resources (DNR) seeks to preserve, protect and enhance the living resources of the state. Working in partnership with the citizens of Maryland, this worthwhile goal will become a reality. This publication provides information that will increase your understanding of how DNR strives to reach that goal through its many diverse programs.

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NORTH BRANCH POTOMAC BASIN

ENVIRONMENTAL ASSESSMENT OF STREAM CONDITIONS

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December 2001

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Resource Assessment Service
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Governor Parris N. Glendening

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FOREWORD

Much of this report is based on results of the Maryland Biological Stream Survey (MBSS), a program funded primarily by the Power Plant Research Program and administered by the Maryland Department of Natural Resources. Field data for the North Branch Potomac basin were collected by the Maryland Department of Natural Resources. Analyses of water chemistry samples was conducted by the University of Maryland's Appalachian Laboratory (AL) under Contract No. MA97-001-003. Much of the initial data analysis for this report was conducted by Versar, Inc. under Contract No. PR-96-055-001\PRFP44 to MDNR's Power Plant Assessment Division.

This report helps fulfill two outcomes in MDNR's Strategic Plan: 1) A Vital and Life Sustaining Chesapeake Bay and Its Tributaries, and 2) Sustainable Populations of Living Resources and Healthy Ecosystems.

ACKNOWLEDGEMENTS

We are grateful to Kelly Surgent, Rachel Burke, Mick Burkett, Dave Neely, and Robin VanMeter for their work in the field. We are also grateful to Katie Meagher of AL for long hours and weekends spent in the laboratory to ensure that holding times and quality control measures were met for water samples. We thank Janis Chaillou and the Versar landowner permission crew for ensuring that permissions to sample streams on private property were obtained in a timely fashion. We also thank various MDNR staff: Marty Hurd, Anthony Prochaska, for contributing to the document and providing Geographic Information Systems (GIS) support. We are also grateful to Dan Boward and Anthony Prochaska for editing; and Lamar Platt and Dung Nguyen for cover design and report layout.

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Maryland Biological Stream Survey

Executive Summary

This report describes existing aquatic resource conditions during 1996 in streams in the North Branch Potomac basin in Maryland. The report also begins to assess water quality and habitat problems in the basin, as well as defining areas of high ecological quality. This information may prove useful as watershed-specific strategies for restoring water quality in the Chesapeake Bay drainage are developed and refined.

The primary source of information for this report is the Maryland Biological Stream Survey (MBSS) conducted by Maryland Department of Natural Resources (MDNR) to characterize Maryland streams, including those within the North Branch Potomac basin. Although the primary focus of the MBSS is on acid deposition impacts, the survey is also being used for other purposes such as reporting on watershed conditions. The MBSS is a statewide survey of first, second, and third-order non-tidal streams designed to characterize current biological and habitat conditions and provide a basis for assessing future trends. The probabilistic design used for the survey, in which all streams have a known probability of being sampled and sites are selected randomly, allows for quantitative estimates of stream characteristics and conditions.

FINDINGS

Water Quality

None of the North Branch Potomac basin's stream miles had dissolved oxygen levels lower than the state water quality criterion of 5 mg/L. While runoff of oxygen-demanding materials does not appear to be a widespread problem in the basin, it could be contributing to poor dissolved oxygen levels in localized areas and Chesapeake Bay.

Nearly 14% of the basin's stream miles were estimated to have acid neutralizing capacity (ANC) less than 0 μeq/L, indicating that chronically acidified streams are a problem in the basin. One half the stream miles in the basin had ANC above 0 but less than 200 μeq/L and thus are susceptible to periodic acidification during large storms. About 36% of the basin's stream miles had ANC greater than 200 μeq/L These are considered well buffered and probably not susceptible to acid deposition impacts.

Acidity is a water quality problem in the North Branch Potomac basin's first through third-order streams. The results of the MBSS Spring sampling indicate that nearly 10% of the basin's stream miles had pH below 5 in 1996. These values represent a onetime measure and provide an indication of chronic acidification. This, however, does not include problems during episodic events.

Elevated nitrogen levels (nitrate-nitrogen greater than 1 mg/L) occurred at 25% of the stream miles in the basin. The primary sources of nitrates appear to be agriculture, but urban runoff and atmospheric deposition are also likely contributors.

Physical Habitat

Nearly one-third (32%) of the basin's stream miles were rated Poor or Very Poor for instream habitat. Some of the likely causes of degraded habitat include the loss of woody debris, channelization, sedimentation, and riparian zone deforestation.

Accordingly to a provisional Physical Habitat Index (PHI), around 65% of the basin's stream miles were rated as having Poor or Very Poor physical habitat and about 7% had Good physical habitat. The PHI combines several aspects of physical habitat that are proven to be the best indicators of habitat quality.

Stream banks in the basin are in relatively good condition; about 74% of stream banks in the basin were considered stable and only about 10% were rated Poor or Very Poor. Eroding stream banks degrade available habitat and may be an important source of sediment and nutrients to Chesapeake Bay.

While about 57% of the basin's stream miles had at least a 50 meter buffer zone, a surprisingly large percentage (32%) had no buffer zone on at least one side of the stream. These streams consequently have reduced protection against runoff and flood events.

Fish

A total of 36 fish species were collected in the North Branch Potomac basin, including six species of gamefish: brook trout, rainbow trout, cutthroat trout, brown trout, smallmouth bass, and largemouth bass.

Based on 1996 sampling results, about 1.6 million fish live in the basin's first through third-order streams. The most abundant species was blacknose dace, a pollution tolerant species, estimated at about five hundred thousand individuals.

Of all the basins sampled, the North Branch Potomac basin had the highest percentage (29%) of stream miles rated as Very Poor by MDNR's Index of Biotic Integrity (IBI) for fish. The fish IBI rated only 28% of the basin's streams as being in Fair or Good condition.

Benthic Macroinvertebrates

Approximately 350 genera of stream-dwelling macroinvertebrates are known to exist in Maryland, and 130 of these were found in the North Branch Potomac basin. Dominant genera were *Amphinemura,* a stonefly, which was present at 70% of the sites, and *Prosimulium*, a black fly, which was present at 69% of the sites.

Based on MDNR's benthic macroinvertebrate IBI, about 31% of all first through third-order stream miles in the basin were assessed as Poor or Very Poor and only about 8% were rated Good. Of the sites that were rated as Fair, 70% were in the lower range and thus susceptible to being degraded to Poor condition.

Reptiles and Amphibians

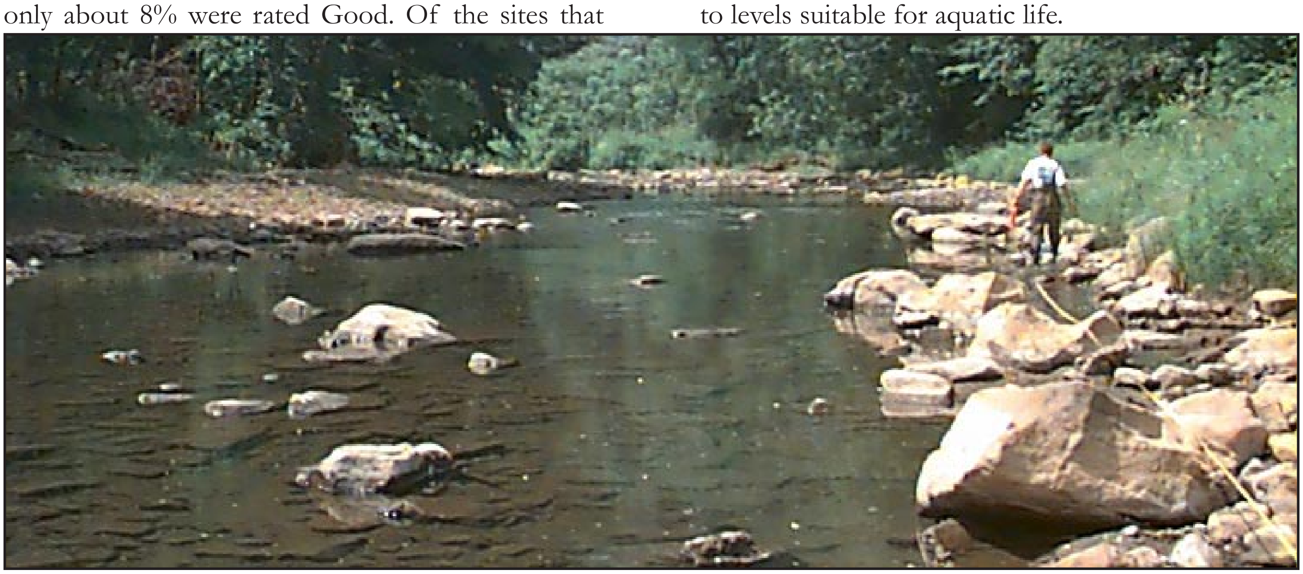
Reptiles and amphibians were present at 90% of the sites sampled in the basin. A total of 22 species of frogs, toads, turtles, salamanders, and snakes were collected.

Freshwater Mussels

No freshwater mussels were observed in the North Branch Potomac basin in 1996. Mussels were observed in the adjacent Youghiogheny and Upper Potomac basins. The absence of mussels in the 1996 samples may be due to the large number of small streams that were sampled.

Summary

The major impacts to non-tidal streams in the basin appear to be poor instream habitat and channel alterations from historical and current mining, industrial and logging activities. Urban and Agricultural land uses are probably contributing as well. Stream acidity from atmospheric deposition is an additional stressor and may be contributing to low biological integrity scores. Acidification of streams may be episodic or chronic and thus may not show up in the "snapshot" of stream chemistry conditions taken by the MBSS sampling crews. However, the impacts of acidic episodes on biological communities may linger on for quite some time after stream pH has recovered to levels suitable for aquatic life.



A Maryland DNR biologist measures out a sampling segment on the North Branch Potomac River during the 1996 MBSS.

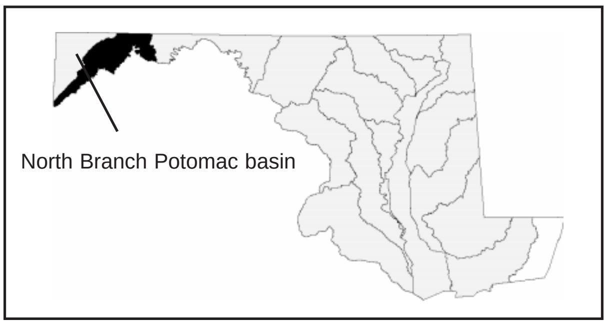
Maryland Biological Stream Survey

Introduction

Chapter One 1

PURPOSE OF THIS REPORT

This report describes aquatic resource conditions in first, second, and third-order non-tidal streams in the North Branch Potomac basin in Maryland during 1996. The report also begins to identify water quality and habitat problems in the basin, along with areas of high ecological value. We hope that this information will prove useful as specific strategies for restoring water quality in Chesapeake Bay and its tributaries are developed and refined.



The North Branch Potomac basin, one of Maryland's 18 major river basins, lies in the northwestern part of the state and includes parts of Allegany and Garrett counties.

STREAM RESOURCES

The flowing waters of Maryland represent a vital lifeblood to its residents. In addition to providing drinking water and water for agricultural and industrial uses, Maryland's streams and rivers offer recreational opportunities, attract tourists, and support commercially and recreationally important fish and shellfish. Forested riparian zones contain some of the richest and most diverse plant and animal communities in the state. These areas help temper the effects of heavy rainfall and storm water runoff, shade the stream channel, increase bank stability, and contribute leaf litter and woody debris--sources of food and habitat for stream biota. In many cases, the aesthetic attraction of streams and rivers has served as a catalyst for economic development. Nearly all of the flowing waters in Maryland, including those within the North Branch Potomac basin, drain to Chesapeake Bay. Therefore, the quality of these systems has a direct impact on the health of the Bay. As most Marylanders know, Chesapeake Bay is one of Maryland's most important economic and natural resources.

Despite these values, Maryland's streams and rivers have been abused and neglected, often converted to flood routing systems or used as drains for unwanted wastes. Increasingly, Marylanders are realizing that our mistreatment of natural resources is neither economically nor environmentally sustainable. Efforts are underway to restore degraded systems and to protect those that are healthy. In the end, the success of these efforts will be determined by how much we cherish these most valuable natural gifts.

INFORMATION SOURCES

The primary data source for this report is the 1996 Maryland Biological Stream Survey (MBSS) conducted by the Maryland Department of Natural Resources (MDNR). Where appropriate, 1993 MBSS data have been used to supplement information regarding fish and herpetofauna distributions. The MBSS is a statewide survey of first, second, and third-order streams designed to characterize current biological and habitat conditions and provide a basis for assessing future trends. The probabilistic design (all streams have a known probability of being sampled and sites are randomly selected) used for the survey allows unbiased estimates of stream characteristics and conditions. For example, the abundance of a given fish species in an entire basin can be validly estimated using the MBSS design. Because first, second, and third-order streams represent approximately 84% of the non-tidal stream miles in the North Branch Potomac basin, MBSS results should accurately represent stream quality. Examination of conditions in small streams also helps identify specific problem areas where local protection, enhancement, and restoration efforts should be focused.

To provide a comparison of past and present conditions, historical information is presented where appropriate and available. In addition, information on land use, hydrology, and other aspects of the basin is provided so that the conditions observed in streams can be placed in the context of human activity.

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Basin Description

Chapter Two 2

This chapter uses existing information to provide an overview of the North Branch Potomac basin, including ecological, recreational, and economic resources. These descriptions provide a context for interpreting the assessment of stream conditions found in Chapter 4.

HISTORY

The first humans to occupy the North Branch Potomac basin were Paleo Indians, who may have arrived as early as 16,000 B.C. Projectile points found in Garrett County definitely place Early Archaic Indians in the basin by about 10,000 B.C. There is evidence of Late Archaic Indians for the period between 3,000 and 1000 B.C. There is a gap in the archeological record from the end of the Late Archaic period up to about one thousand years ago. Substantial archeological evidence exists of Indians of the Monongahela culture during the Late Woodland or Late Prehistoric period (A.D. 1000 to A.D. 1600). Sometime before A.D. 900, Algonquin Indians migrated to the area from the Great Lakes region (Gude 1984).

When European settlers first arrived in the Chesapeake Bay area in the early 1600s, they found a collection of Algonquin settlements and chiefdoms. These groups included the Piscataways, Nacostines, Nanticokes and Potopacos on the Maryland side and the tribes or settlements of the Powhatan Confederacy on the Virginia side.

As the European settlers expanded into the Potomac River basin they exploited old rivalries between tribes and uprooted native American settlements. By the end of the seventeenth century most Algonquins had been killed or forced to move to the west.

The 1700s brought waves of German and Scotch-Irish farmers into the upper Potomac basin. These farmers grew primarily corn and wheat and raised livestock. Interest in making the river navigable in order to exploit the resources of western lands led to the formation of the Ohio Company by Thomas Lee in 1747.

The latter half of the eighteenth century was a period of warfare, first against the French and their Indian allies, and then later for independence from British rule. In the North Branch Potomac basin, the French and Indian War prompted the construction of a military road by George Washington and General Braddock . This road, known as Braddock's Road, was completed in 1754-55. Little fighting occurred in the basin, but its farms and industries helped supply the continental army during the Revolutionary War.

In the nineteenth century the North Branch Potomac basin was a major transportation route for westward expansion. Settlers moving west mostly followed old Indian trails. One of these routes, built roughly on top of the old Braddock's Road, became the first federally funded highway project, Route 40, or the "National Road". Completed in 1818, the National Road linked Cumberland Maryland and the Potomac River region to the Ohio-Mississippi River basin. The flow of trade along this route transformed the Potomac region. Population and industry increased dramatically along the river. On the same day in 1828, construction began on the C&O Canal in Washington D.C. and on the B&O Railroad in Baltimore. These two projects were in a race to reach Cumberland, Maryland and connect their respective cities to the flow of materials from western markets. The railroad reached Cumberland eight years ahead of the canal. The railroad's early arrival and superior freight moving ability transformed Baltimore into a major industrial center. When the Civil War broke out, the economic link between residents of the North Branch Potomac basin and the industrial city of Baltimore made most residents of the basin sympathetic to the North.

The early twentieth century brought the industrial revolution and increased coal mining and logging to the basin. Industry jobs brought an influx of Germans, Hungarians, Poles, and Scandinavians into the region. The two World Wars brought increased demand for the basin's coal and timber and spurred further industrial development. This rapid industrial growth and increased population resulted in severe environmental degradation of the Potomac River.

During the early twentieth century a series of floods and competition with railroads resulted in the close of the C&O canal. By the mid-1900s the basin's coal and timber resources were largely depleted and many of the basin's company towns went into decline. This decline in industrial activity reduced the environmental stresses to the North Potomac basin. However, much of the basin's landscape was ravaged by years of strip mining and clear cutting. Abandoned mines leaked acid into nearby streams, poisoning aquatic organisms. Acid mine drainage continues to be a major problem in the basin's streams to this day, and the entire basin has been logged at least once. (Gude 1984, WETA 2000).

In the late twentieth century many people became aware of the Potomac River's severe environmental problems. The Interstate Commission on the Potomac River Basin (ICPRB) published a report in 1954 that described the severe industrial pollution of the North Branch of the Potomac River. In 1960, the Upper Potomac River Commission treatment plant in Westernport, Maryland, was opened. This plant was designed to clean up pollution in the North Branch. In 1965, President Lyndon Johnson called the Potomac River a "national disgrace". The river's plight moved Congress to pass the Clean Water Restoration Act in 1966. President Richard M. Nixon signed legislation in 1971 creating the Chesapeake & Ohio Canal National Historical Park. In 1987 the governments of Maryland and West Virginia signed a cooperative agreement to develop a plan for acid mine drainage abatement. A plan to restore water quality in the North Branch was signed by these states and the ICPRB in 1993. The Potomac was designated an American Heritage River in 1998. This designation streamlined the process by which community groups in the watershed could acquire federal funds for activities that restore and protect the ecological, social and historical fabric of the basin (Gude 1984, WETA 2000, ICPRB 2000).

BASIN CHARACTERISTICS

The North Branch Potomac basin drains approximately 499 square miles in Allegany and Garrett counties in Maryland, as well as another 844 square miles in portions of Hampshire, Hardy, Mineral, Preston and Tucker counties in West Virginia and portions of Bedford and Somerset counties in Pennsylvania (MOP 1994). There are a total of 594 miles of first, second, and third-order non-tidal streams in the Maryland portion of the basin. First-order streams make up 65% of the stream miles, while second and third-order streams constitute nearly 35% of the total. Forth-order and larger streams account for approximately 16% of the basin's stream miles (Roth et al. 1999). The eastern part of the basin, east of Dan's Mountain, lies within the Ridge and Valley physiographic province. The western portion of the basin lies within the Appalachian Plateau physiographic province.

Climate exerts a major influence on basin water quality, as it affects the water budget and precipitation chemistry. The quantity and chemical composition of water added through precipitation, coupled with the regions underlying geology dictate the chemical and biological features of the basin. The climate in the basin is generally temperate. With a mean annual temperature of 47° F, the basin is cooler than most of Maryland thus allowing brook trout to survive (USGS 1996). Summers are hot and humid with an average daily maximum temperature of 86° F. Winters are cold, averaging a minimum temperature of 25° F. Mean annual precipitation from 1948 to 1997 was 40 inches. May is typically the wettest month, with an average precipitation of 4 inches, and February is usually the driest month with an average precipitation of 2.7 inches (RESI 1998).

The North Branch Potomac basin's topography is hilly. Elevation ranges from approximately 600 to 3,000 feet above sea level. The soils of the area tend to be gently sloping to steep, moderately deep, well drained and stony. The basin's soils originate from geologic strata formed during the Precambrian (>600 m.y.a.), Silurian (405-425 m.y.a.), Mississippian (310-345 m.y.a.), and Permian/Pennsylvanian (230-310 m.y.a.) periods. The Precambrian strata are comprised of a mixture of materials including schist, metagraywacke, quartzite, marble and metavolcanic rocks. The other three strata all contain various amounts of shale, sandstone and limestone. Siltstone is found only in the Mississippian and Permian/Pennsylvanian formations. Coal and clay are found only in the Permian/Pennsylvanian strata which occurs only in the Appalachian Plateau portion of the basin (MGS 1968, USGS 1996).

Geology can greatly influence water chemistry and water quality. Sedimentary rocks (or their metamorphic equivalents) such as limestone and dolomite, contain carbonate and magnesium. This gives them the ability to buffer streams and groundwater against the effects of acid deposition. Some silicate rocks, such as glauconite, biotite, hornblende and calcium pyroxenes are less soluble but still acid neutralizing. Quartz, some other silicate rich rocks, and metal oxides, are largely insoluble and may have little influence on water chemistry. Carbonaceous-sulfidic siltstones, shales and schists, peat, coal, and organic muds are most likely to yield reduced, oxygen-poor, acidic water. (Peper et al. 1998). All of these types of rocks/soils are present in the North Branch Potomac basin to varying extents and their influence on water chemistry varies from one stream to another.

The basin's forested areas are dominated by several canopy forming tree species including red maple, chestnut, white, northern red and bear oaks, eastern hemlock, and black cherry. Common understory trees and shrubs include white ash, yellow and black birch, sassafras, flowering dogwood, mockernut hickory, pignut hickory, American chestnut, ironwood, mountain laurel, maple leaf viburnum, Virginia creeper, tall deerberry, service berry, early low blueberry, and witch hazel. The dominant environmental factor influencing the basin's plant species is water availability. Other important factors are soil composition and elevation. These three factors are closely linked. Areas of high elevation tend to be drier with shallower soils composed of more weather resistant materials. Conversely, low lying areas tend to be wetter and have deeper soils that contain more erodible materials. However, most of the basin's trees and shrubs will grow in their preferred hydrologic regime regardless of soil type. Plant species strongly influenced by soil composition include bear oak, which prefers soils containing quartzite, sandstone and shale, and eastern hemlock and black and yellow birch, which prefer sandstone, shale and gabbros. The distribution of black birch is also strongly influenced by elevation (Brush et al. 1977).

LAND USE AND HUMAN POPULATION

The dominant land use in the North Branch Potomac basin is forest (76%). Agriculture is the second largest

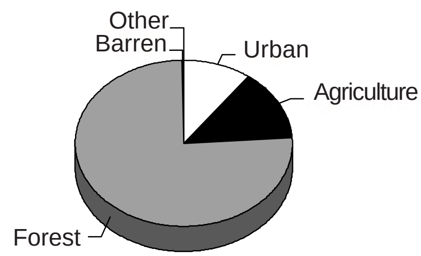


Figure 1. Land use in the North Branch Potomac basin (MOP 1994).

land use (14%), and urban lands account for just over 10% of the basin's land use. Wetlands and barren lands together comprise less than 1% of the basin's land (Figures 1 and 3). Based on 1990 census data, population increased from about 56,000 people in 1990 to about 56,600 in 1995. The North Branch Potomac is one of the most rural and least densely populated basins in the state (44 persons/km^2). The basin's population is increasing slowly and is projected to grow about 2.8% to roughly 58,700 people by 2020 (Figure 2; MDNR 1997a).

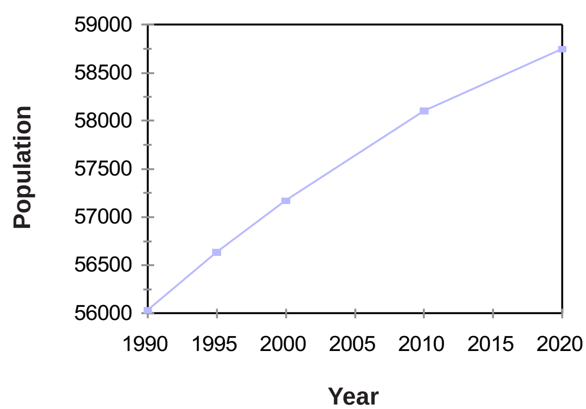
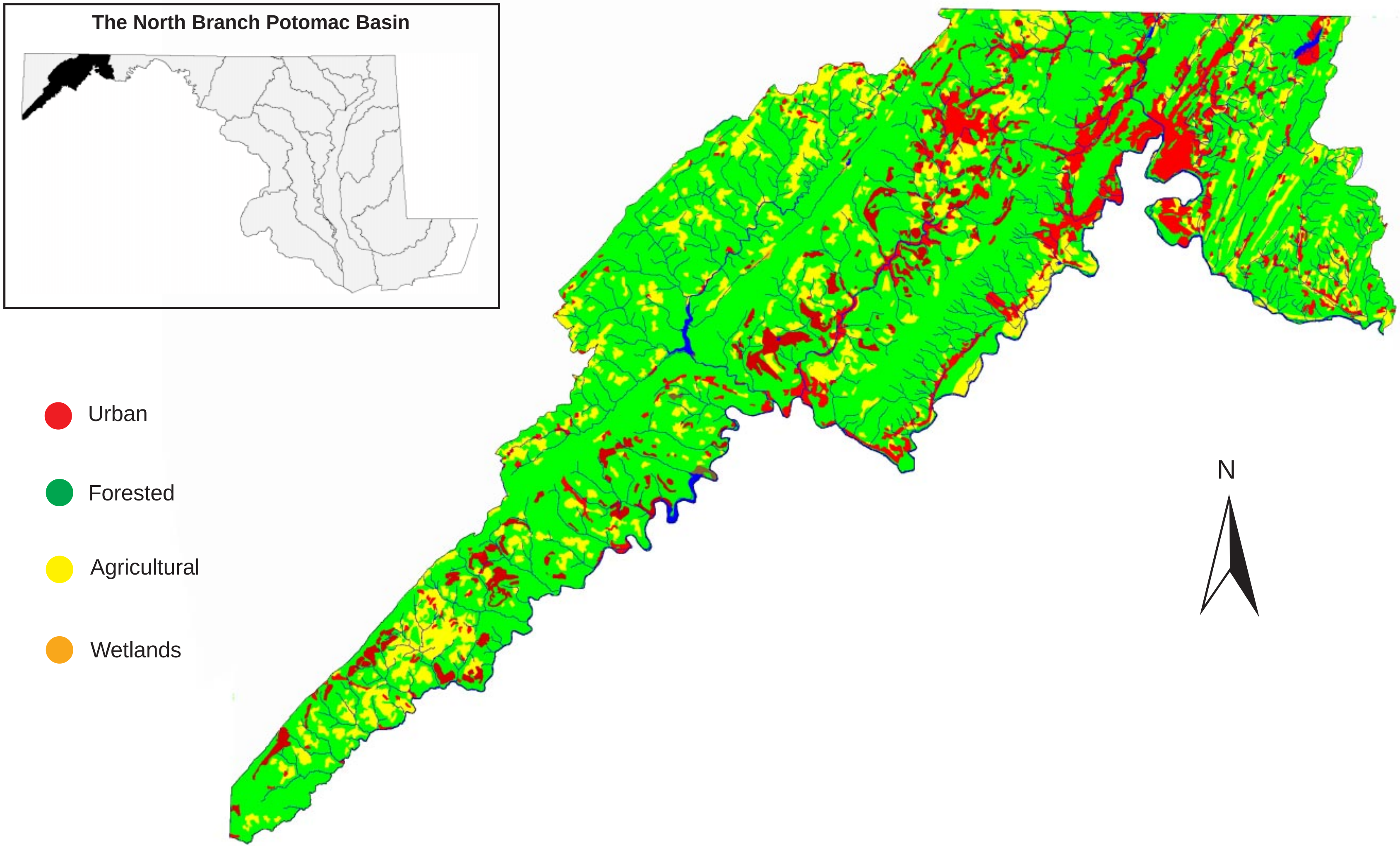


Figure 2. Population growth projections for the North Potomac basin (MOP 1994).

WATER QUALITY

The Maryland Department of the Environment (MDE) classifies all surface waters in Maryland by their "designated use". All waters of the state receive at least a Use I designation; that is, they are protected for contact recreation, fishing, and protection of aquatic life and wildlife. Use II waters are suitable for shellfish harvesting, while Uses III and IV are designated as natural and stocked trout waters, respectively. Additional designations are made for waters recognized for their function as drinking water supplies (COMAR 1997).



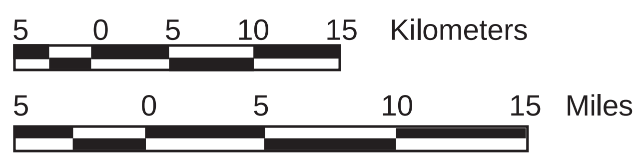


Figure 3. Land use in the North Branch Potomac basin (MOP 1994).

Section 305(b) of the federal Water Pollution Control Act requires states to report on the status of surface and ground waters to the U.S. Environmental Protection Agency. According to Maryland's 1998 report, surface waters of the North Branch Potomac basin were classified as Use I-P (water contact recreation, aquatic life and public water supply), Use III-P (natural trout and public water supply) or Use IV-P (put-and-take trout and public water supply). Elevated levels of bacteria, nutrients, sulfate and iron, and low pH have been observed in some of the basin's waters. Sources of bacteria and nutrients were ruptured sewer lines and unspecified non-point sources. High sulfate and iron, and low pH was attributed to acid mine drainage (MDNR 1998).

RESOURCE VALUES

Recreational Resources

The North Branch Potomac basin has numerous parks, forests, and recreational areas. State parks in the basin include New Germany State Park, Big Run State Park, and Dan's Mountain State Park. Other outdoor recreation areas include Savage River State Forest, Potomac State Forest, and Dans Mountain Wildlife Management Area. These areas offer fishing, hunting, trapping, canoeing, picnicking, camping, swimming, hiking, boating, nature studies, mountain biking, and off-road vehicle riding.

Ecological Resources

The North Branch Potomac basin contains many wetlands that are distinct from those found in the central and eastern parts of the State. Based on water and nutrient characteristics, these wetlands can be categorized as being one of three types of peatlands: ombotrophic, oligotrophic or minerotrophic. Ombotrophic peatlands are the most acidic and nutrient poor of the three types. These peatlands receive most of their water, and thus nutrients, from precipitation. At the other end of the continuum, minerotrophic peatlands receive water from springs and seeps. Water from these sources tends to be more nutrient rich and less acidic. Wetlands that fall between these two extremes are classified as "oligotrophic". Due to their unique soil and water characteristics, all three wetland types provide habitat for a multitude of rare plant species and some rare insects that depend on them. Endangered animal species found in these areas include mountain earth snakes, northern coal skinks and the southern water shrew. Several types of state listed birds have been documented nesting in these peatlands including the alder flycatcher and the Nashville warbler. There are about 30 peatlands scattered about the basin, covering somewhere between 300 and 700 acres of land. Many more acres of peatlands have no doubt been destroyed by past mining, logging and agricultural activities. In the late 1980s, the Maryland Natural Heritage Program, at the request of the Maryland Bureau of Mines, conducted an inventory of these peatlands. Peatlands were classified according to their ecological importance and recommendations were made on how to preserve them. The most important areas were placed on a list of "areas unsuitable for mining". Some of these areas are still threatened by logging, livestock grazing, ditching, impounding and other human disturbances (MDNR 1991).

Extractable and Renewable Resources

There are two areas of coal reserves called "basins"; the George's Creek and Potomac "basins" contain about 354 and 223 million tons of coal, respectively. Despite these reserves, there are currently only four active mines (Carey 2000). The basin also produces high grade fire clays, which are made into bricks at the Big Savage Fire Brick Company. Other mineral deposits of commercial value include sandstone, limestone and shale. Timber resources are dominated by mixed hardwoods. Softwoods are harvested in lesser amounts and are primarily comprised of white pine. Wood products are the largest industry in the basin. (Frieswyk and DiGiovanni 1988, MDE 2000a, City of Frostburg 2000).

The peatlands of the Appalachian Plateau are ecologically important habitats that support many rare plants and animals

Fishery Resources

Recreational fishing is economically important in the North Branch Potomac basin. Species sought by anglers include largemouth and smallmouth bass, and brook, brown, cutthroat, and rainbow trout. Several state records for brook, brown, cutthroat, and rainbow trout have come from the North Branch Potomac basin.

CITIZEN INVOLVEMENT

During the last decade, an increasing number of concerned citizens have become involved in organizations and programs working to protect and restore Maryland's aquatic resources. Many such organizations focus their work on a particular watershed and take part in monitoring activities, community outreach, and preservation issues. The following lists some of the groups that are active in the North Branch Potomac basin (ACB 1996).

To find out how to get involved in water quality monitoring and watershed issues in the North Branch Potomac basin contact:

Chesapeake Bay Foundation
162 Prince Georges Street
Annapolis, MD 21401

Interstate Commission on the Potomac River Basin
Suite 300
6110 Executive Blvd.
Rockville, MD 20852-3903

Potomac River Association
1185 Clarks Mill Road
Hollywood, MD 20636

Potomac River Greenways Coalition
Suite 300
6110 Executive Blvd.
Rockville, MD 20852-3903

Maryland Save Our Streams
258 Scott's Manor Drive
Glen Burnie, MD 21061

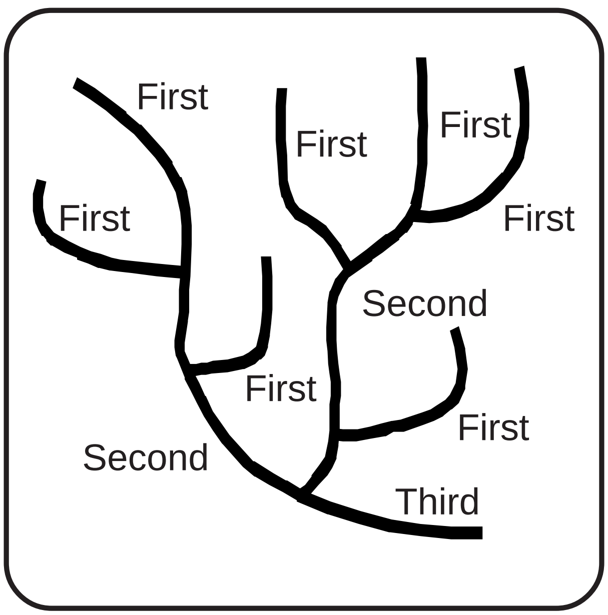
The Nature Conservancy - Maryland Chapter
P.O. Box 4051, 110 N. Division Street
Salisbury, MD 21803

...or check the U.S. Environmental Protection Agency's website, ***Surf Your Watershed***, at: http://www.epa.gov/surf/

Survey Design and Methods

Chapter Three 3

This chapter briefly outlines the approach used by the MBSS to assess stream resources of the North Branch Potomac basin. The sampling design used for this assessment differs from other stream surveys that have been conducted in Maryland. Randomly selected sampling sites on first, second, and third-order non-tidal streams (Strahler 1964) were chosen by computer rather than selected by the investigator. This approach allows estimates to be calculated for an array of ecological factors such as fish density and stream habitat condition. Non-randomly selected sites were also sampled to provide additional information on fish distributions. Figure 4 shows the location of random and nonrandom sites sampled during the 1996 MBSS.



STREAM ORDER

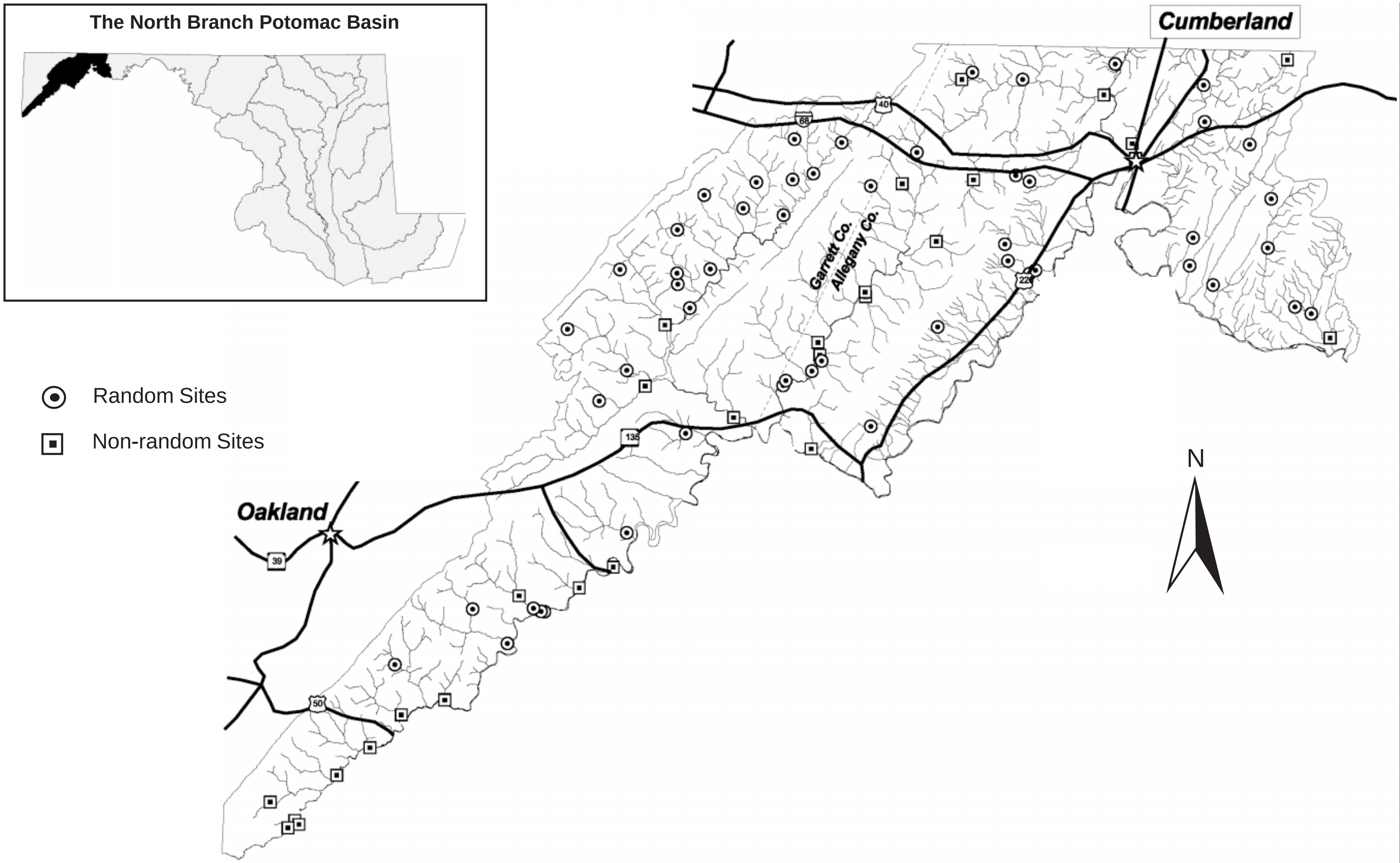
Stream order is a simple way to measure stream size. The smallest permanently flowing stream is termed first-order, and the union of two first-order streams creates a second-order stream. A third-order stream is formed where two-second order streams join. Stream order is directly related to watershed area.

After landowner permissions were obtained, sample sites were located with Global Positioning System (GPS) receivers, fish and benthic macroinvertebrates were collected, and physical habitat features were evaluated using methods patterned after EPA's Rapid Bioassessment Protocols (Plafkin et al. 1989). Reptiles, amphibians, and mussels were also surveyed on a presence/absence basis. Water quality was sampled using protocols previously established for acid rain studies in Maryland (MDNR 1988). Because the initial purpose of the MBSS was to assess the effect of acid rain on Maryland streams and rivers, other important water quality measures such as phosphorous and turbidity were not measured.

Because most stream sites in the North Branch Potomac basin were on private land, landowner permissions were sought for each randomly selected site. This procedure required contact with property owners, usually by phone. Overall, 86% of the landowners contacted in the basin gave DNR permission to have streams on their property sampled by the MBSS.

All catchments draining to MBSS sampling sites were delineated and land use (MOP 1994) was estimated for each. Throughout all sampling and data management activities, an extensive Quality Control program was employed. Additional technical information about the methods used to survey streams and survey results can be found in Appendices A through D of this report, in Roth et al. (1999), and in Kazyak (1996).

MBSS biologists prepare to sample a section of the Savage River.



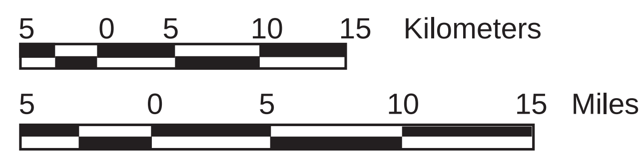


Figure 4. Location of 1996 sites in the North Branch Potomac basin. Major highways, population centers, and other features are shown for reference.

This chapter uses 1996 MBSS data from 57 randomly selected (quantitative) sampling sites to describe the current status of non-tidal streams in the North Branch Potomac basin. All sites were sampled for water chemistry, physical habitat, fish, and benthic macroinvertebrates. Where appropriate, other data have been used from non-random (qualitative) sites to supplement information regarding fish and herpetofauna distributions. A map of these sites is shown in Figure 4, and a list of streams sampled in the basin is presented in Appendix B.

GENERAL CHARACTERISTICS OF THE NORTH BRANCH POTOMAC BASIN

All sites were located in the Ridge and Valley and Appalachian Plateau physiographic provinces, where streams tend to be moderately to steeply sloped with many riffles to aerate the water. Of the fifty-seven sites sampled, sixteen were first-order streams, twenty-one were second-order, and the remaining twenty were third-order. Stream gradient ranged from 0.5% to 17.5%. Wetted width varied from 0.5 meters to 18.3 meters, with an average width of 5.0 meters.

> Dissolved oxygen (DO) is one of the most basic requirements of aquatic organisms, thus DO levels play an important role in shaping biological communities in streams. DO in streams may be low due to nutrient-rich runoff and groundwater inputs from urban and agricultural areas, oxygen demanding organic chemicals in point source discharges, or the breakdown of naturally-occurring organic material such as leaves. The State of Maryland has established a minimum surface water criterion of 5 milligrams per liter (mg/L, also known as parts per million) for DO. When DO is low (i.e., less than 5 mg/L), only those organisms adapted to low DO can persist. In the Ridge and Valley and Appalachian Plateau physiographic provinces, streams typically have riffles where water bubbles over rocks. Riffles help to keep DO levels high by aerating the water. During MBSS summer sampling, dissolved oxygen is measured only once during the day.

WATER QUALITY

During the spring index period, whole water grab samples were collected at each site for laboratory analysis of pH, acid neutralizing capacity (ANC), conductivity, sulfate, nitrate-nitrogen, and dissolved organic carbon (DOC). Summer index period sampling included *in situ* measurements of dissolved oxygen (DO), pH, temperature, and conductivity at each site to further characterize water quality conditions. Water chemistry data from the 1996 quantitative sites are presented in Appendix C.

Dissolved Oxygen

None of the stream miles in the basin had summer dissolved oxygen values below the state water quality criterion of 5.0 mg/L (COMAR 1997). DO samples ranged from 6.0 to 10.1 mg/L and averaged 8.2 mg/L. It should be noted that these data only reflect first through third-order streams and do not take into account larger tributaries where DO problems are more likely to occur.

pH and Acid Neutralizing Capacity

Significant adverse impacts on aquatic life are known to occur when pH values fall to 5.0, and below 4.5 faunal exclusion occurs (Allan 1995, Jefferies and Mills 1990). Acidification of streams can be chronic (i.e., year round) or episodic (seasonal or storm event related), depending on the capacity of the stream to buffer acid inputs, but both may result in increased mortality and/or decreased reproductive success of fish and benthic macroinvertebrates.

> Acidity is an important aspect of stream health. The balance between free hydrogen ions (which increase acidity) and negative ions (which decrease acidity) is measured as pH. The capacity of soil or water to absorb acids without changing the ion balance is known as its buffering capacity, measured as alkalinity or Acid Neutralizing Capacity (ANC). Streams with ANC less than 0 µeq/L are acidic and have no buffering capacity. Streams with baseflow ANC between 0 and 200 µeq/L are only moderately buffered and may periodically have low pH levels during rain or snowmelt events. Those streams with ANC greater than 200 µeq/L are well-buffered. Under acidic conditions, certain metals such as aluminum are dissolved into water and reach levels that can be lethal to aquatic organisms. Acidity in streams is affected by rain, snow, fog, and atmospheric dust, geology and soil characteristics, organic matter, and most importantly in the North Branch Potomac basin, drainage from coal mines.

Chronically acidified streams generally contain only those organisms highly tolerant of acid conditions. In contrast, streams which are only episodically acidified can and often do support less tolerant "invaders" from better buffered downstream areas during summer low flow periods.

The results of the MBSS Spring sampling indicate that nearly 10% of the basins stream miles had pH below 5 in 1996. The two major sources of stream acidity in the North Branch Potomac basin are acid mine drainage (AMD) and acidic deposition (i.e., acid rain and other atmospheric inputs).

AMD is responsible for a long history of problems in the basin's streams. Problems related to AMD include direct physiological impacts of low pH on stream biota, high levels of heavy metals, addition of fine sediment, and cementing of substrates. A recent MDNR study estimated that 20% (119 miles) of the basin's stream miles were affected by AMD. To minimize AMD problems in the North Branch Potomac basin, calcium is being added to streams in several locations via automated dosers. However, these dosers are only effective as long as funding is provided for their continued operation.

A limestone doser on an unnamed tributary to the North Branch Potomac River in Kitzmiller, Maryland.

Acid Mine Drainage in the North Branch Potomac Basin

The Industrial Revolution of the early 20th century brought on a boom in coal mining in the North Branch Potomac basin. By the mid-1900s the basin's coal resources were largely depleted and many of the mines were closed. This decline in mining activity reduced the environmental stresses to the basin. Nature gradually reclaimed much of the landscape but abandoned mines continued to leak acid into many of the basin's streams.

The actual mileage of acid mine drainage (AMD) impacted streams is unknown. A 1974 Maryland Bureau of Mines (BOM) study estimated that 452 stream miles in Maryland were impacted by AMD, including 270 miles in the North Branch Potomac basin (MDNR 1974a). A 1999 EPA fisheries survey reported 152 miles in the basin as being biologically impacted by AMD, including 42 stream miles with no fish (Pavol 2000).

If the number of AMD impacted stream miles is still unknown, the number of restored stream miles is well documented. In 1993, the BOM began installing dosers on several AMD impaired streams. These dosers periodically add lime and/or limestone to streams as a way to raise pH to levels. Since the BOM began the doser project in 1993, more than 30 stream miles have been restored. These stream miles include 4 miles of Laurel Run, 23.5 miles of the North Branch Potomac River, and 3 miles of Lostland Run. The doser project has also contributed significantly to water quality improvements in the 950 acre Jennings-Randolph Lake and 8 miles of river below the dam. Most of these streams now support healthy brook trout populations and are regaining a natural appearance. Several state record trout have been caught in the river below Jennings-Randolph Lake

At its beginning, the doser project cost $90,000/year to operate 4 dosers. Since then, through innovative methods such as finding corporate sponsors, the BOM now operates 6 dosers at a yearly cost of about $54,000 (Mills 2000).

Although acidic deposition has received less attention than acid mine drainage, its contribution to stream acidity in the basin may be more widespread. Recent MBSS results estimate that about 38% (226 miles) of the basin's stream miles were affected by acidic deposition as the dominant acid source. About 5% of the basin's stream miles were estimated to be affected by both AMD and acidic deposition (MDNR 1999b).

Nearly 14% of the basin's stream miles were estimated to have acid neutralizing capacity (ANC) less than 0 μeq/L indicating that chronically acidified streams are a problem in the basin (Figure 5). Half the stream miles had ANC above 0 but less than 200 μeq/L and thus may be susceptible to episodic acidification during large storms. Streams with ANC greater than 200 μeq/L are considered well buffered and probably not susceptible to acid deposition impacts. About 36% of the stream miles were estimated to be in this category.

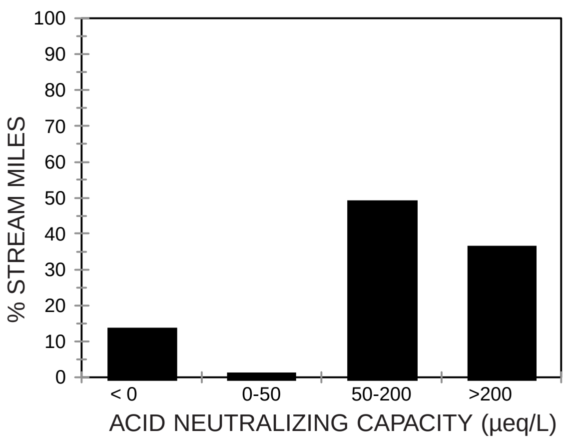


Figure 5. Acid Neutralizing Capacity (ANC) for non-tidal streams of the North Branch Potomac basin, 1996.

Nitrates and Dissolved Organic Carbon

Two important indicators of the sources of acidity in Maryland streams are nitrate nitrogen and dissolved organic carbon (DOC).

One important source of nitrates in Maryland streams is deposition from the atmosphere. However, leaching into groundwater and direct runoff from agricultural lands, sewage treatment plants, and leaking septic systems are more important sources of nitrates to streams. Stream nitrate concentrations greater than 1 mg/L are elevated compared to undisturbed streams (Morgan 1995).

The primary source of DOC in streams is leachate from decaying leaves and other plant material that are natural sources of organic matter found within the stream drainage network itself, especially wetlands. DOC concentrations greater than 10 mg/L indicate that organic acids contribute significantly to overall acidity, but DOC levels between 5 and 10 mg/L also indicate that natural sources are contributing to overall acidity in a stream (Morgan 1995).

Twenty-five percent of the basin's stream miles had elevated (>1 mg/L) nitrate levels, suggesting that most of the streams do not have a problem with excess nutrients (Figure 6). The single grab samples collected during spring baseflow conditions represent relative nitrate contributions from mostly groundwater inputs. Although these data do not account for

Acid mine drainage in Laurel Run, a North Branch Potomac River tributary, has stained the rocks with iron oxide precipitates.

seasonal or temporal variability, they do provide an effective method for identifying watersheds with elevated nutrient levels, particularly from groundwater. In streams with high groundwater nitrate concentrations, a reduction in point and non-point sources of nitrates to surface waters will only be noticeable after groundwater sources are purged.

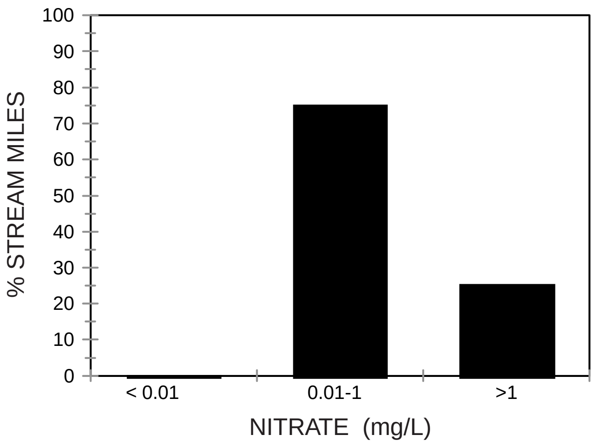


Figure 6. Nitrate levels for non-tidal streams of the North Branch Potomac basin, 1996.

One hundred percent of the basin's stream miles had DOC levels less than 5 mg/L, suggesting that organic acids do not contribute significantly to overall stream acidity. The basin-wide average DOC concentration was 1.7 mg/L.

PHYSICAL HABITAT

> **What is habitat?**
> The physical/chemical theater in which the ecological play takes place; it is a template for the biota, their interactions, and their evolution (ITFM 1995).

Many physical habitat characteristics of streams are important determinants of ecosystem structure and function. Although a large number of habitat variables are measured by the MBSS, they can be grouped into four general categories: instream habitat, channel character, riparian zone, and aesthetics/remoteness. Most variables are classified as either Good, Fair, Poor, or Very Poor. A description of selected MBSS physical habitat variables is included in Appendix D.

Instream Habitat

The complexity and stability of habitat in a stream typically has the strongest relationship to abundance and diversity of the biological communities that occur there. Important instream habitat characteristics include: 1) amount and quality of stable habitat for fish shelter; 2) diversity of depths and flows; and 3) quality, composition, and heterogeneity of the stream bottom, and attachment sites for benthic macroinvertebrates.

Many instream habitat problems result from the removal of woody debris from stream channels; little to no buffer between pastures, croplands, urban lands, and streams; increases in sediment loads; and modification of stream channels because of increased runoff. These impacts are common when lands are developed for agricultural or urban land uses.

Almost a quarter (24 %) of the basin's streams were rated as having Good instream habitat. Forty-five percent were rated as Fair and about one-quarter fell into the Poor category. A small percentage (5 %) of the basin's streams were rated as Very Poor (Figure 7).

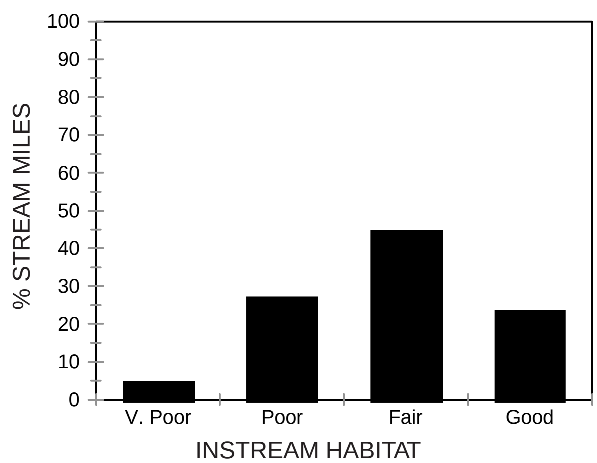


Figure 7. Instream habitat scores for non-tidal streams of the North Branch Potomac basin, 1996.

Increased sediment loads tend to reduce the complexity and stability of the stream bottom, resulting in a loss of habitat for fish and benthic macroinvertebrates. Another common outcome is the coating or burial of stones by silt and sand in riffle areas. The MBSS measures this condition as "embeddedness". The percent embeddedness of substrate in riffles provides an indication of the amount of sediment moving downstream and the availability of interstitial spaces for stream biota. In the North Branch Potomac basin embeddedness is also affected by AMD. In AMD streams, precipitates coat substrate and fill in voids between rocks, rendering habitats highly unsuitable. Since many benthic macroinvertebrates such as mayflies and stoneflies use the spaces between rocks as living quarters, high sediment loads and AMD precipitates reduce benthic macroinvertebrate diversity and abundance in streams. In the North Branch Potomac basin, about fifty-six percent of the stream miles were rated as either Poor or Very Poor (Figure 8).

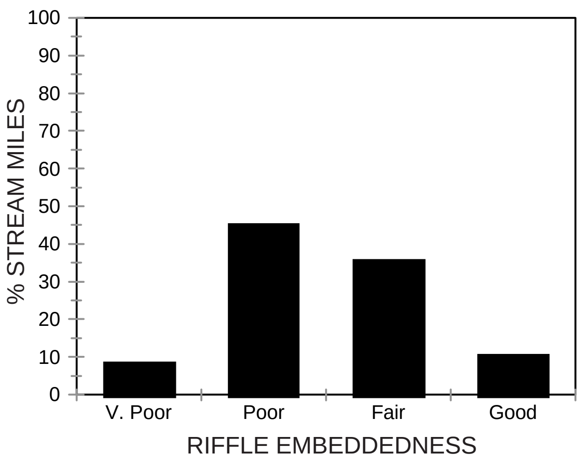


Figure 8. Riffle embeddedness ratings for the North Branch Potomac basin, 1996.

One factor which contributes to decreased instream habitat quality is the low abundance of woody materials (e.g., logs, limbs, and rootwads) along stream banks and in stream channels compared to historical levels. Wood in streams greatly enhances habitat quality for both fish and benthic macroinvertebrates by providing a diverse array of shelter, depths, and velocities. Woody debris traps and retains leaves in the stream channel, providing a vital food supply for many benthic macroinvertebrates.

The North Branch Potomac basin had the second lowest density of woody debris per stream mile of Maryland's 18 major basins. There were an estimated 44 pieces of woody debris per stream mile in the basin, well below the statewide average of 91 pieces per mile. As a measure of comparison, wood controls 80% or more of the stream channel in streams within old growth forests (Maser and Sedell 1994).

In addition to the effects still lingering from the original clear cutting of the North Branch Potomac basin, a continuing cause of the reduced abundance of woody debris and rootwads in the basin is related to prevailing forestry practices. In today's managed forests, trees are rarely allowed to achieve senescence (old age and natural death); thus one of the vital and controlling elements of instream habitat (large dead trees and tree limbs) is largely prevented from falling into streams. In addition, woody debris that falls into streams during logging is routinely removed.

Channel Characteristics

Large-scale disturbance in stream channels may result from watershed development or channel modification. Evidence of stream channel disturbance includes excessive bar formation, the presence of artificial structures (e.g., concrete armoring and rip-rap), reduced stream flows because of water removal for irrigation and other uses, and severe bank erosion.
Only twelve percent of the basin's stream miles were estimated as having very heavily altered channels. The majority of the basin's stream miles (34%) showed little or no evidence of channel alteration. The remaining 54% of stream miles were estimated to be either moderately (10-40%) or heavily (40-80%) altered (Figure 9).

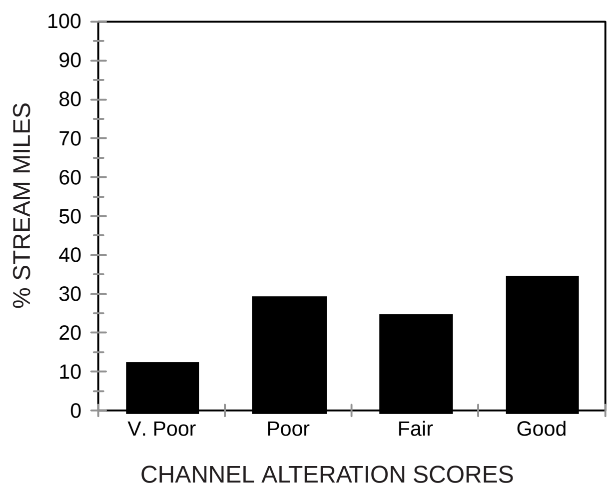


Figure 9. Channel alteration rating for non-tidal streams of the North Branch Potomac basin, 1996.

Typically, as lands within a basin are developed for agricultural, industrial or residential purposes, stream banks and channels become destabilized. This is evidenced by highly eroded banks and the formation of sand/silt bars in slow moving channel areas. In the North Branch Potomac basin, about 10% of stream miles showed evidence of bank stability problems (Very Poor and Poor), while about 74% of the stream banks were in Good condition (Figure 10). Instability of stream banks and channels limits the availability of instream habitat through sedimentation and ultimately increases nutrient and sediment transport to Chesapeake Bay.

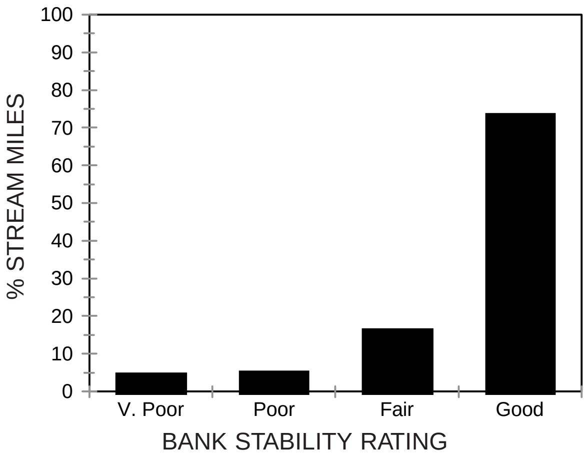


Figure 10. Bank stability rating for non-tidal streams of the North Branch Potomac basin, 1997.

Riparian Zone

> Riparian zones are the areas alongside streams, rivers, and other water bodies. When these areas are vegetated, they play a vital role in structuring and maintaining physical habitat, energy flow, and aquatic community composition. Vegetated (trees, shrubs, and grasses) riparian zones act as buffers by decreasing runoff and preventing particulate pollutants from entering streams (Plafkin et al. 1989). Trees and shrubs also provide energy inputs to the stream in the form of leaf litter and woody debris, stabilize stream channels, supply overhead and instream cover for fishes and other aquatic life, and moderate stream water temperature.

Forest cover decreases exposure of the channel to direct sunlight and helps prevent warming of stream waters above their natural range. Other vegetation types, such as old field, mowed lawn, and tall grass, do not provide shade, but they do provide buffering of precipitation runoff and can also function as food and habitat sources for aquatic and terrestrial species.

In the North Branch Potomac basin, eighty-seven percent of the stream miles were considered well to moderately shaded (50% to 100%) while only 1.1% were very poorly shaded (< 25%). Riparian zone width tended to be either Good (>50m) or Very Poor (0m) (Figure 11). About 56% of stream miles had buffers greater than 50m wide while 32% were estimated to have no riparian zone. The remaining 12% had riparian zones between 1 and 49 meters wide. The dominant riparian buffer type was forest.

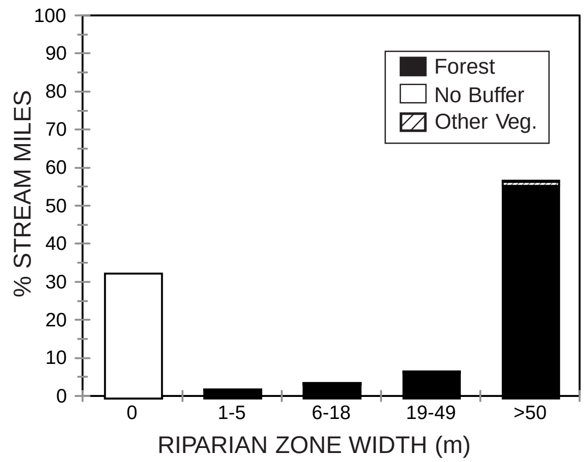


Figure 11. Riparian zone width and type for non-tidal streams of the North Branch Potomac basin, 1996.

Aesthetics and Remoteness

The aesthetic and remoteness ratings provide a qualitative estimate of the level of anthropogenic influence on a stream system and, in turn, may indicate stress on the biological community. Aesthetically, the basin's streams rated well, with 75 percent of the stream miles in Fair or Good condition (Figure 12). Remoteness ratings were also high with the majority of stream miles being more than one-quarter of a mile from the nearest road and showing little or no evidence of human activity (Figure 12). Twenty-three

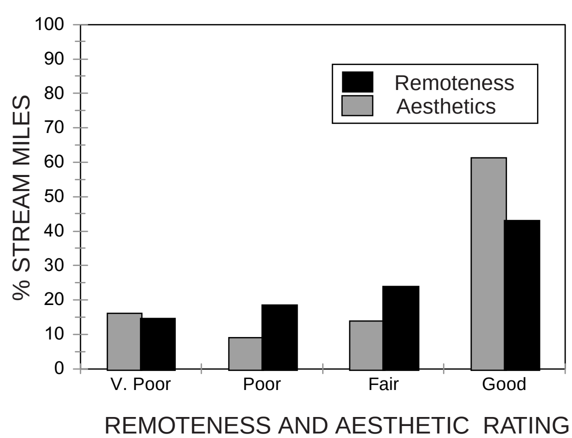


Figure 12. Remoteness and Aesthetic ratings for non-tidal streams of the North Branch Potomac basin, 1996.

percent of the streams were within one-quarter mile of the nearest road but not immediately accessible by trail and exhibited moderately wild characteristics. The remaining 33% of streams were within a quarter of a mile of a road and showed strong evidence of human activities.

HABITAT QUALITY BASED ON A PHYSICAL HABITAT INDEX (PHI)

In addition to evaluating habitat components individually, the MBSS has developed a provisional index which combines those aspects of physical habitat that have proven to be the best indicators of biological condition. Based on the Physical Habitat Index (PHI), around 65% of the basin's stream miles have Poor or Very Poor physical habitat, and about 7% have Good habitat (Figure 13). The large percentage of stream miles estimated to be Poor is in part due to the basin's large proportion of first-order streams. PHI scores tend to increase with stream order reflecting the greater diversity of habitat available in larger streams (Hall et al. 1999).

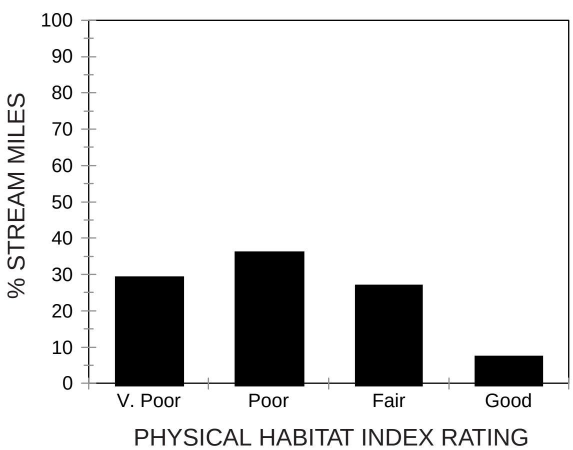


Figure 13. Physical Habitat Index (PHI) rating for non-tidal streams of the North Branch Potomac basin, 1996.

FISHERY RESOURCES

General Description

A total of 12,527 fish representing 36 species and 8 families were collected in the North Branch Potomac basin during 1996. Based on these data, total fish abundance was about 1.6 million fish. Basin-wide population estimates for individual species ranged from more than five hundred thousand individuals for blacknose dace, to less than 100 individuals for golden redhorse, brown bullhead, American eel and yellow perch (Table 1). The 5 most abundant fish species, in decreasing order, were: blacknose dace, mottled sculpin, central stoneroller, longnose dace, and fantail darter. Together these species made up more than 75% of the fish in the basin. (Figure 14).

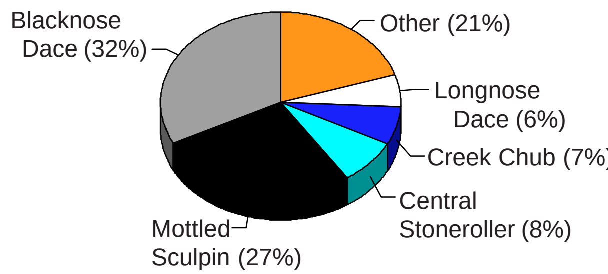


Figure 14. Relative abundance of the five most common fish species in non-tidal streams of the North Branch Potomac basin, 1996.

Gamefish

Six species of gamefish were collected. In order of abundance, these species were brook, rainbow, cutthroat and brown trout, and smallmouth and largemouth bass. Of these six species, only the brook trout is native to Maryland. The basin had the fifth highest abundance of brook trout in the state and the second highest abundance of legal sized gamefish (MDNR 1999b). The state records for brook, cutthroat, brown, and rainbow trout have all come from the North Branch Potomac basin.

Introduced Species

Nine non-native fish species were found the North Branch Potomac basin, which had the lowest density of non-native fish (32 fish/mile) of all basins sampled by the 1995-1997 MBSS. In decreasing order of abundance these ten species were rainbow trout, rock bass, smallmouth bass, green sunfish, bluegill, largemouth bass, cutthroat trout, brown trout, and common carp. Four of these species (smallmouth bass, bluegill, green sunfish, and rock bass) are native to the adjacent Youghiogheny basin. Three species (rainbow trout, cutthroat trout, and largemouth bass) are native to other areas of North America, while brown trout and common carp are of European origin (MDNR 1999b).

Table 1. Estimated total abundance and percentage occurrence of fish species collected in the North Branch Potomac basin in 1996 (first, second, and third-order non-tidal streams combined).

Family / Common Name	(*Scientific Name*)	Percentage Occurrence[1]	Population Estimate[2,3]	Standard Error
Anguillidae				
American Eel	(*Anguilla rostrata*)	1.11	72	64
Cyprinidae				
Blacknose Dace	(*Rhinichthys atratulus*)	67.78	512,287	103,812
Bluntnose Minnow	(*Pimephales notatus*)	7.78	4,953	3,505
Central Stoneroller	(*Campostoma anomalum*)	17.78	126,786	81,358
Common Carp	(*Cyprinus carpio*)	1.11	n/a[3]	n/a[3]
Common Shiner	(*Luxilus cornutus*)	8.89	8,783	4,578
Creek Chub	(*Semotilus atromaculatus*)	44.44	107,546	36,269
Cutlips Minnow	(*Exoglossum maxillingua*)	6.67	28,905	12,342
Fallfish	(*Semotilus corporalis*)	5.56	1,153	1,479
Golden Shiner	(*Notemigonus crysoleucas*)	2.22	n/a[3]	n/a[3]
Longnose Dace	(*Rhinichthys cataractae*)	30.00	91,780	35,973
River Chub	(*Nocomis micropogon*)	4.44	3,040	2,377
Rosyface Shiner	(*Notropis rubellus*)	2.22	n/a[3]	n/a[3]
Rosyside Dace	(*Clinostomus funduloides*)	10.00	11,716	7,752
Spotfin Shiner	(*Cyprinella spiloptera*)	6.67	432	432
Spottail Shiner	(*Notropis hudsonius*)	2.22	n/a[3]	n/a[3]
Catostomidae				
Creek Chubsucker	(*Erimyzon oblongus*)	1.11	144	133
Golden Redhorse	(*Moxostoma duquesnei*)	3.33	72	66
Northern Hogsucker	(*Hypentelium nigricans*)	12.22	1,090	592
White Sucker	(*Catostomus commersoni*)	34.44	42,058	14,254
Ictaluridae				
Margined Madtom	(*Noturus insignis*)	3.33	1,781	1,102
Yellow Bullhead	(*Ameiurus natalis*)	5.56	144	100
Brown Bullhead	(*Ameiurus nebulosus*)	1.11	72	79
Salmonidae				
Brown Trout	(*Salmo trutta*)	5.56	212	152
Brook Trout	(*Salvelinus fontinalis*)	32.22	49,833	16,507
Rainbow Trout	(*Oncorhynchus mykiss*)	13.33	18,701	1,047
Cutthroat Trout	(*Oncorhynchus clarki*)	3.33	288	163
Cottidae				
Mottled Sculpin	(*Cottus bairdi*)	42.22	425,435	172527
Potomac Sculpin	(*Cottus girardi*)	26.67	45,821	14,670
Centrarchidae				
Bluegill	(*Lepomis macrochirus*)	10.00	1,317	858
Green Sunfish	(*Lepomis cyanellus*)	4.44	1,483	1,365
Largemouth Bass	(*Micropterus salmoides*)	6.67	737	515
Smallmouth Bass	(*Micropterus dolomieu*)	6.67	2,586	1,379
Pumpkinseed	(*Lepomis gibbosus*)	7.78	212	133
Redbreast Sunfish	(*Lepomis auritus*)	1.11	976	976
Rock Bass	(*Ambloplites rupestris*)	12.22	7,184	4252
Percidae				
Fantail Darter	(*Etheostoma flabellare*)	32.22	77,797	23,731
Greenside Darter	(*Etheostoma blennioides*)	7.78	5,565	4,622
Rainbow Darter	(*Etheostoma caeruleum*)	4.44	144	144
Tessellated Darter	(*Etheostoma olmstedi*)	1.11	n/a[3]	n/a[3]
Yellow Perch	(*Perca flavescens*)	3.33	72	77

[1] Percent of all random and non-random sites where each species was collected.
[2] Total abundance (number per basin) adjusted for capture efficiency (Heimbuch et al. 1997).
[3] Non-random site information was not used in calculating population estimates.

Brook Trout versus Brown Trout

In 1987, MDNR implemented trophy trout regulations for the Savage River tailwater area. The new regulations created a Trophy Trout Management Area extending from the Savage River reservoir 6.5 km downstream to the mouth of the river. Since that time, MDNR biologists have been monitoring the area's wild trout population to track trends in trout numbers, species composition, growth rates, and reproductive success.

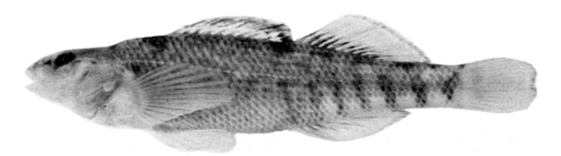
Recent results have indicated that brown trout, an introduced species, are beginning to dominate the area at the expense of the native brook trout population. Since 1996, the brook trout population has declined to the lowest levels seen since monitoring began in 1987. This has happened in spite of the fact that brook trout reproduction has routinely exceeded that of brown trout.

Other scientists have reported similar findings where brook and brown trout occur together. Brown trout tend to be larger in size and more aggressive than brook trout, thus enabling them to out compete brook trout for limited space. Brook trout are then displaced into less favorable habitats (Faush and White 1981, Waters 1983, Dewald 1990). Brown trout are also effective predators on juvenile brook trout while consuming fewer of their own young (Alexander 1977).

The situation in the Savage River tailwater area is not characteristic of the rest of the watershed. Above the Savage River reservoir, brook trout occupy many more stream miles than brown trout. Wild brown trout are present in less than 10% of the upper North Branch Potomac basin. The continued existence of the area's wild brook trout population is a desired management goal. MDNR biologists continue to monitor the status of brook trout in the Savage River tailwater area and are looking into ways to prevent further declines in this important species (Pavol and Klotz 1999).

Rare and Uncommon Species

None of the fish species identified in the basin in 1996 are on the State or Federal endangered species lists (MDNR 1997b). Due to its probability-based sampling design, the MBSS was able to develop an independent, statistically reliable list of rare species. The 15 species on the list were observed at no more than 2% of the 905 random MBSS sites sampled between 1995 and 1997. Of these 15 species, one, the rainbow darter, was found in the North Branch Potomac basin. This species was present at 0.11% of the MBSS sites and its population in small streams was estimated to be 124 individuals, the least of any species collected by the survey. (MDNR 1999b).

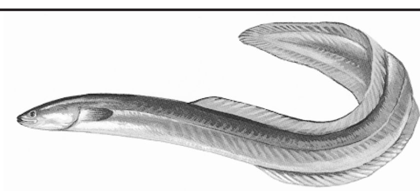


The rainbow darter, which was collected in the North Branch Potomac basin, was the least abundant species collected by the MBSS between 1995 and 1997.

Migratory Species

There are three types of migratory fish in Maryland, anadromous, semi-anadromous, and catadromous. Anadromous species live as adults in estuarine or marine waters, moving into freshwater to spawn. Semi-anadromous species live as adults in estuarine or riverine waters, also moving into freshwater to spawn. However, semi-anadromous species migrate lesser distances. Conversely, catadromous American eels live as adults in freshwater, migrating to marine waters to spawn.

Only one migratory species, the American eel, was collected in the basin in 1996, and this species was represented by only one individual. The paucity of migratory species in the basin can be attributed to the presence of a natural barrier to fish migration, Great Falls on the Potomac, downstream from the basin (Pavol 2000).



The American eel was the only migratory fish collected in the North Branch Potomac basin in 1996.

BENTHIC MACROINVERTEBRATES

Benthic macroinvertebrates, or more simply "benthos", are animals without backbones that are larger than 0.5 millimeter (the size of a pencil dot). These animals live on and under rocks, logs, sediment, debris, and aquatic plants during some stage of their lives. The benthos include crustaceans, such as crayfish; mollusks, such as clams and snails; aquatic worms; and the immature forms of aquatic insects, such as stonefly and mayfly nymphs.

Of the approximately 350 genera of stream-dwelling benthic macroinvertebrates in Maryland, 130 were found in the North Branch Potomac basin. The number of taxa collected per site ranged from 2 to 28. The two most common taxa were *Amphinemura,* a stonefly, which was present at 70% of the sites, and *Prosimulium*, a black fly, which was present at 69% of the sites. Other common taxa and their respective percent occurrences were: *Ephemerella* (a mayfly; 66%), *Leuctra* (a stonefly; 56%), *Parametriocnemus* (a midge; 56%) and *Rhyacophila* (a caddisfly; 52%). Forty-five taxa were uncommon (found at less than 2% of all sites) including 22 genera of the order Diptera (true flies), 7 genera of the order Trichoptera (caddisflies), 6 genera of the order Ephemeroptera (mayflies), and 3 genera of the order Plecoptera (mayflies). Other uncommon taxa included three orders that were represented by only 2 genera: Tubificida (worms), Basommatophora (small clams), and Coleoptera (beetles), and three orders that were represented by only one genera: Veneroida (small clams), Megaloptera (fish flies), and Lepidoptera (butterflies). A list of all benthic taxa collected in the basin, along with their functional feeding groups and tolerance classifications, is presented in Appendix F.

STREAM QUALITY BASED ON AN INDEX OF BIOTIC INTEGRITY (IBI)

MDNR recently developed an Index of Biotic Integrity (IBI) for non-tidal stream fish (Roth et al. 1999) and benthic macroinvertebrate (Stribling et al. 1998) communities that are effective tools for evaluating ecological conditions in streams. Using these IBIs, various characteristics of the fish and benthic community are compared to results from high quality reference streams and scored. The summary score is then used to assess ecological conditions of streams in the basin as Good, Fair, Poor, or Very Poor.

The results of the fish and benthic macroinvertebrate IBIs indicate some biological impairment throughout the North Branch Potomac basin (Figures 15, 16, 17). Only about 28% percent of the streams miles were rated Fair or better using the fish IBI. However, 68% were rated Fair or better when assessed with the benthic macroinvertebrate IBI. Forty-one percent of the basin's stream miles were classified as Poor or Very Poor by the fish IBI versus 31% using the benthic IBI. The basin had the highest percentage of stream miles rated as Poor by the fish IBI (29%) of the 18 basins sampled in 1995-97. The benthic IBI rated only 14% of the steam miles as Very Poor. Although results varied considerably between the two IBI's, both suggest that biological impairment is a problem in the basin, and the potential exists for further degradation.

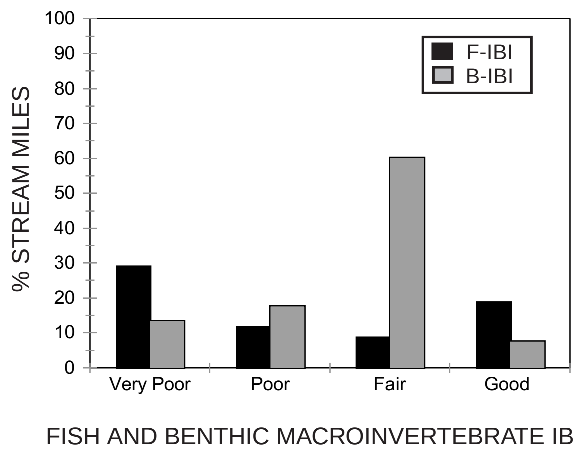
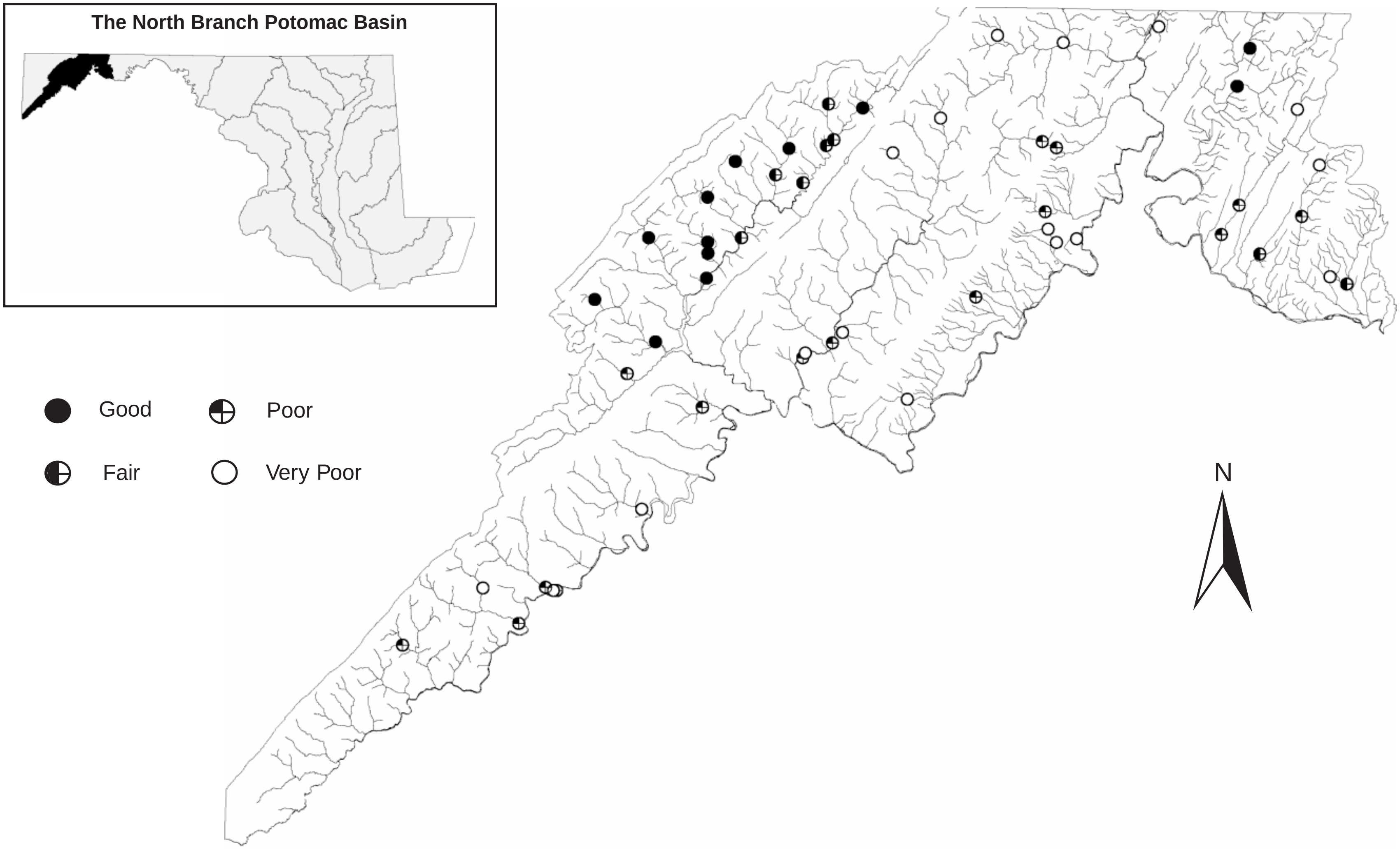


Figure 15. Fish (F-IBI) and benthic macroinvertebrate (B-IBI) Index of Biotic Integrity scores for non-tidal streams of the North Branch Potomac basin, 1996.

Thirty-two percent of the stream miles were not assessed with the fish IBI because of the index's watershed size criterion. Because of the inherent physical limitations of streams in small watersheds (i.e., small channel dimensions and lack of stable water flow) and the effect on fish community dynamics, sites with watersheds less than a 300 acres were excluded from the analysis. However, benthic macroinvertebrates are less affected by these conditions and thus were not limited by the size of the watershed. The discrepancy between the indices may be attributed to several factors, including each IBI's classification rating, differences in response to environmental stress between fish and benthic macroinvertebrates, and the number of sites assessed by each IBI. A detailed discussion of these factors is presented in Chapter 5.



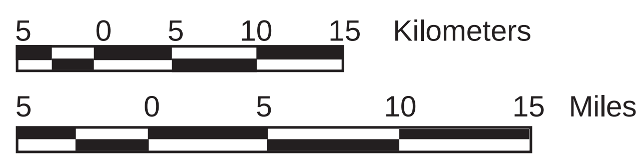


Figure 16. Stream ecological conditions in the North Branch Potomac basin based on the fish Index of Biotic Integrity (F-IBI), 1996.

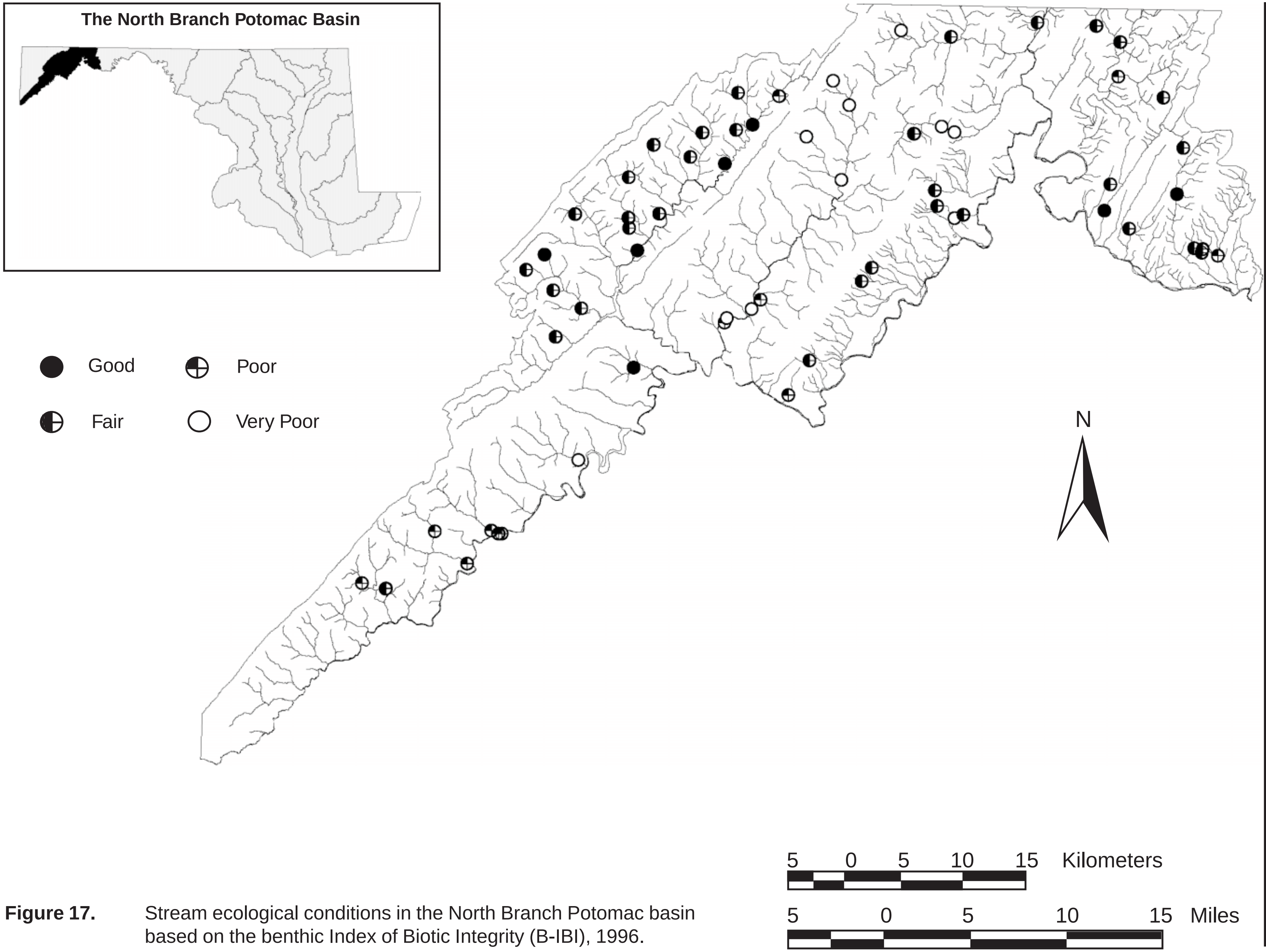


Figure 17. Stream ecological conditions in the North Branch Potomac basin based on the benthic Index of Biotic Integrity (B-IBI), 1996.

REPTILES AND AMPHIBIANS

Reptiles and amphibians were found at more than 90% of the quantitative sites sampled in 1996. An average of 3 species were observed per site. Salamanders were the most frequently encountered group. The three most abundant salamander species, Northern two-lined, Northern dusky and mountain dusky, occurred at 21.9%, 13.5% and 11.6% of the sites, respectively (Table 2). The remaining species all occurred at less than ten percent of the sites. Only one occurence was noted for the pickerel frog, American toad, black rat snake, Northern ringneck snake, and Jefferson salamander. The Jefferson salamander is on the Maryland Heritage and Biodiversity Program's watch list and is considered rare to uncommon in Maryland.

FRESHWATER MUSSELS

No freshwater mussels were observed in the North Branch Potomac basin in 1996. Mussels were oberved in the adjacent Youghiogheny and Upper Potomac basins. The absence of mussels in the 1996 samples may be due to the large number of first-order streams that were sampled. Mussel diversity in streams oftens increases as stream order increases (Strayer 1983, Watters 1993).

Table 2. List of herpetofauna observed in the North Branch Potomac basin, 1996.

Frogs and Toads		**Freq. (%)**
Bullfrog	*(Rana catesbeiana)*	1.3
Green Frog	*(Rana clamitans melanota)*	7.1
Pickerel Frog	*(Rana palustris)*	0.6
Wood Frog	*(Rana sylvatica)*	2.4
American Toad	*(Bufo americanus)*	0.6
Turtles		
E. Box Turtle	*(Terrapene carolina carolina)*	1.3
Wood Turtle	*(Clemmys insculpta)*	1.3
Snakes and Lizards		
Black Rat Snake	*(Elaphe obsoleta obsoleta)*	0.6
N. Water Snake	*(Nerodia sipedon sipedon)*	3.9
E. Garter Snake	*(Thamnopis sirtalis sirtalis)*	1.3
N. Ringneck Snake	*(Diadophis punctatus edwardsii)*	0.6
Salamanders		
Jefferson Salamander	(*Ambystoma jeffersonianum*)	0.6
Longtail Salamander	*(Eurycea longicauda longicauda)*	1.3
Mountain Dusky Salamander	*(Desmognathus ochrophaeus)*	11.6
Northern Dusky Salamander	*(Desmognathus fuscus fuscus)*	13.5
Northern Slimy Salamander	*(Plethodon glutinosus)*	7.7
Northern Spring Salamander	(*Gyrinophilus porphyriticus porphyriticus)*	5.2
Northern Two-Lined Salamander	*(Eurycea bislieatus)*	21.9
Red Salamander	*(Pseudotriton ruber)*	4.5
Red Spotted Newt	*(Notopthalmus viridescens viridescens)*	1.9
Redback Salamander	*(Plethodon cinereus)*	1.9
Seal Salamander	*(Desmognathus monticola)*	5.8

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Information from the Maryland Biological Stream Survey has provided us with a snapshot of living resources, stream conditions, and major stressors to the aquatic habitat in the North Branch Potomac basin. Like most Maryland watersheds, the North Branch Potomac basin consists of a network of streams that range in quality from extremely degraded to very healthy.

MBSS' one-time measurements of water chemistry indicate that most streams in the basin have acceptable levels of water quality, however, about ten percent of streams in the basin violated state water quality criterion for pH. Low pH values are likely the result of acid mine drainage and acid deposition. A recent MDNR report estimated that 20% of stream miles in Western Maryland are either episodically or chronically acidified (MDNR 2000b). This is an increase from 12% as reported in a previous MDNR report (MDNR 1988). Also, elevated nitrate-nitrogen levels were found in approximately 25% of stream miles and were confined to the northeastern region of the basin (Figure 18; next page). This is probably due to the high percentage of forested land, which averaged more than 80% in the watersheds from which sites were sampled. Agricultural and urban runoff, as well as point source inputs, are major contributors of excess nitrate. However, because agricultural acreage exceeds urban acreage by about 19 to 1 in the basin, agricultural practices are probably the most important source of nitrate-nitrogen. Because this condition represents both current and historical nutrient additions, it may be years to decades before the benefits of nutrient reduction efforts begin to be realized.

Although most of the basin's streams meet state water quality standards, there is substantial evidence of biological impairment. The MDNR's fish Index of Biotic Integrity classified 41% of the stream miles as Poor or Very Poor. The results of the benthic IBI support this conclusion, classifying 31% of the stream miles as Poor or Very Poor. Also, approximately 70% of sites classified as Fair by the benthic IBI scored within the lower range of that category and are therefore susceptible to being degraded to Poor condition. Unlike other basins, IBI scores of the North Branch Potomac basin did not exhibit any trends with associated land use practices. Typically, IBIs are inversely related to urban land use, but given that urbanization is not widespread in the basin this relationship was not apparent.

A potential influence on the outcome of the fish and benthic IBIs is that each index has been calibrated for Coastal Plain and non-Coastal Plain streams; the fish IBI further divides non-Coastal Plain into a Highland and Eastern Piedmont region. Many sub-watersheds in the North Branch Potomac basin contain "coldwater" streams with naturally occurring conditions that are different from the "typical" non-Coastal Plain system. Coldwater systems are naturally low in fish species diversity and thus tend to be underrated by the fish IBI. A good indicator of coldwater streams is the presence of brook trout. Brook trout were present at 23 (40%) of the sites sampled in 1996. Of these, eight (35%) were rated as Poor or Very Poor by the fish IBI. Furthermore, the second highest average abundance of brook trout was in sites that were classified as Very Poor (Figure 19). The eight brook trout sites with low IBI scores included seven sites on four streams with historical AMD problems. The presence of brook trout in these

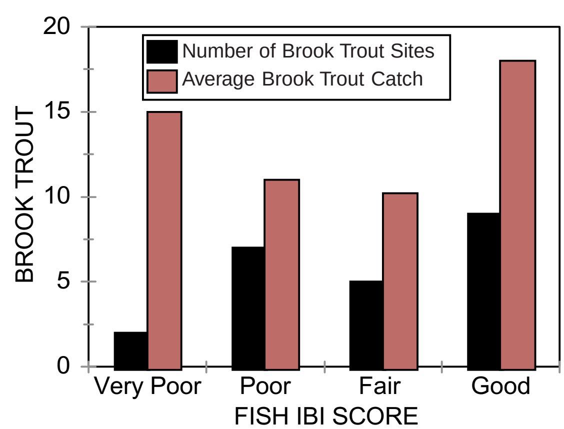

Figure 19. Number of sites with brook trout and mean number of brook trout captured in each Fish IBI rating category for the North Branch Potomac basin, 1996.

Figure 18. Nitrate concentrations (mg/L) in the North Branch Potomac basin (1996).

streams may be a sign of improved water quality following the State's restoration efforts.

Only 7% of stream miles in the basin appear to be in Good condition based on the Physical Habitat Index, with 65% of the stream miles in Poor or Very Poor condition. Of the 28% of stream miles in Fair condition, 66% were in the lower half of the range. Degradation in the basin's streams is largely the result of inadequate vegetated buffers along stream banks, a lack of rootwads and woody debris in stream channels, excess siltation, and a lack of suitable substrate for benthic macroinvertebrates. These problems are mainly the result of historical and ongoing mining and logging, and to a lesser extent agricultural and urban land uses. Although 56% of the basin's stream miles have riparian buffers 50 m wide or greater, 32% of stream miles had no functional riparian buffers on at least one side. This lack of protective vegetation along streams is an obvious starting point in the restoration process because riparian buffers improve both water quality and physical habitat.

The basin had the lowest density of woody debris and rootwads of any of Maryland's major river basins. The lack of these two vital habitat components is closely linked to the lack of vegetative buffers since forests along streams are a source of woody materials. Embeddedness of riffle habitats from excess siltation and AMD was a problem in 54% of the basin's stream miles. This condition indicates that large amounts of sediment and/or precipitates are present in the basin's streams. Once these materials reach streams, they are difficult to remove. Therefore, it is important to attack these problems at their source. Conservative land use practices, such as maintaining and increasing forested buffers, and controlling storm water runoff, are the keys to controlling siltation. In contrast, strict enforcement of existing mining regulations and clean up of historical problems are essential to minimize AMD problems. Unstable stream banks were not a widespread problem, with approximately ninety percent of the basin's stream miles being rated as having little evidence of erosion or potential for future problems.

Forty-one percent of the basin's stream miles were rated as Poor or Very Poor in terms of human alterations of the stream's natural channel. Channel alteration impacts include dredging, artificial armoring, and heavy deposits of gravel or sand resulting in extensive bar formation. These problems are further compounded in streams that experience increased runoff due to land use changes. When land use changes result in increased impervious surfaces or decreased stabilizing vegetation, the ecological integrity of the stream and downstream areas are threatened. In general, results of the MBSS suggest that physical habitat degradation is an important problem in the basin.

Forty-one species of fish were collected from the streams of the North Branch Potomac basin, the eighth highest of the state's eighteen river basins. However, the average number of fish species per segment was only 3.7, tied for the lowest in the state. Ten of the 41 species were non-native and most, if not all, of these species were introduced by fishery managers or anglers. In terms of the number of fish per stream mile, these non-natives represented the lowest density (32 fish per mile or 1.2% of total) of all basins sampled during the 1995-1997 MBSS. From a recreational standpoint, some of these introductions have been beneficial, but ecological impacts, such as the reduction in distribution and abundance of native species, have occurred and will continue. Unfortunately, there is little historical information about fish community composition in the basin. Therefore, it is difficult to determine how the introduction of non-native fishes has influenced the distribution and abundance of native species. The MBSS results establish a useful benchmark of current fish species composition, distribution, and abundance that can be used to track future changes. Because of the recognized potential for detrimental effects, the Chesapeake Bay states have started a review process for proposed introductions of non-native species that should reduce the number of unwise introductions.

Six species of gamefish were collected: largemouth and smallmouth bass, and brook, brown, cutthroat and rainbow trout. Brook trout, the basin's only native gamefish species, were the most abundant gamefish in the basin. Brook trout density was fifth highest out of the seven basins where they were found. The basin also had the second highest abundance of harvestable gamefish of the State's 18 major basins.

American eel was the only migratory species documented in the North Branch Potomac basin and only one individual was captured. The Great Falls on the Potomac River is a natural migration barrier to most migratory fish species. Therefore, the low number of migratory species in the basin is not a cause for concern.

The amount of rain and snow falling onto a watershed is an important factor in shaping the biological community of a stream. Dry, low flow periods are considered stressful to aquatic life due to higher water temperatures, lower dissolved oxygen levels, and a reduction in the amount of available habitat. Conversely, extremely heavy rainfall and high flows may result in large-scale changes in physical habitat, temporarily lethal water quality conditions, mortality of bottom-dwelling species through crushing and burial by moving rocks and sediments, and transport of aquatic animals to less favorable habitats.

In 1996, the total annual rainfall in the North Branch Potomac basin was about 9.5 percent above the 50 year average (Figure 20; NOAA 1997). Higher than average flows may have affected species distributions and exacerbated habitat degradation problems in some streams. Without long-term data for climate, flow, and stream ecological conditions, it is difficult to determine relationships among these environmental factors and stream quality. When the MBSS is repeated in future years, more light will be shed on this important subject.

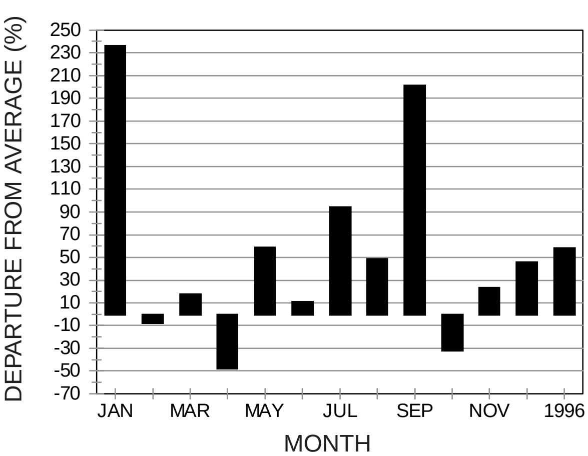

Figure 20. Monthly rainfall in the North Branch Potomac basin, 1996. Bars indicate the departure, expressed as a percentage, from the average monthly rainfall from 1965 through 1995.

Given the level and types of stream impacts noted in 1996 and the projected changes in land use, human population size, and water demands in the North Branch Potomac basin, the biological communities and other ecological attributes of streams in the basin will need special attention so they do not become more degraded in years to come. Comprehensive implementation of best management practices (BMPs), such as riparian zone protection and reforestation, may partially offset impacts. However, it is important to note that BMPs may reduce, but not eliminate, the ecological impacts of human disturbance. Just as it took time for detrimental practices to be felt in the environment, it will take time for the effects of remediation efforts to show a positive change. The "snapshot" quality of MBSS sampling will make these changes, both good and bad, easier to detect.

This report illustrates that valuable stream resources still exist. However, in many ways the basin still suffers from mistakes of the past. The entire area has been logged, including riparian zones, and as a result unstable stream channels are common, physical habitat has been greatly reduced, and even forested streams carry elevated sediment loads. In addition, effects of coal mining continue to be felt in the basin's streams. However, some progress has been made in this area, especially in the streams that have limestone dosers installed. These problems can be lessened, but great cost is typically involved. Over time, we must work to restore conditions in the basin for future generations. We also need to make a concerted effort to protect and enhance the remaining high quality resources in the basin, and elsewhere. Only in this way can we learn to exist in a sustainable manner.

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SYNOPSIS OF MBSS DESIGN AND SAMPLING METHODS

The MBSS is intended to provide unbiased estimates of the condition of streams and rivers of Maryland on a local (e.g., drainage basin or county) as well as a statewide scale. To date, the MBSS has focused on wadeable, headwater streams. The survey is based on a probabilistic stream sampling approach where random selections are made from all sections of streams in the state which can physically be sampled. The approach supports statistically-valid population estimation of variables of interest (e.g., largemouth bass densities, miles of streams with degraded physical habitat, etc.). When repeated, the MBSS will also provide a basis for assessing future changes in ecological condition of flowing waters of the state. The MBSS is now a part of MDNR's long-term monitoring strategy and includes 4th order streams in the sampling design.

The study area for the MBSS includes each of the 18 major drainage basins of the state, and a total of three years was required to sample all 18 basins. For logistical reasons, the state was divided into three geographic regions (east, west, and central) with five to seven basins in each region. Each basin was sampled at least once during the three year cycle, and one basin in each region was sampled twice so that data collected in different years could be combined into a single statewide estimate for each of the variables of interest.

The sampling frame for the MBSS was constructed by overlaying basin boundaries on a map of all blueline stream reaches in the state as digitized on a U.S. Geological Survey 1:250,000 scale map. Sampling within basins was restricted to non-tidal, first, second and third-order (Strahler 1964) stream reaches, excluding unwadeable or otherwise unsampleable areas. An additional restriction was that only public land or privately-owned sites where landowner permissions was obtained were sampled.

During 1996, the MBSS sample sites for the North Branch Potomac basin were selected from a comprehensive list of headwater stream reaches. To provide adequate information about each size of stream, an approximately equal number of first, second and third-order streams were sampled during spring and summer, with the number of sites in a basin being proportional to the number of stream miles in the entire state.

Benthic macroinvertebrates and water quality samples were collected during the spring index period from March through early May, while fish, herpetofauna, *in situ* stream chemistry and physical habitat sampling were conducted during the low flow period in the summer, from June through September.

In the spring, water samples were collected and analyzed for pH, acid-neutralizing capacity (ANC), sulfate (SO_4), nitrate (NO_3), conductivity, and dissolved organic carbon (DOC) in the laboratory. These variables primarily characterize the sensitivity of the streams to acid deposition and other anthropogenic stressors to a lesser extent. Benthic macroinvertebrates collected in the spring were identified to family and genus level in the laboratory.

Habitat assessments were conducted in the summer using metrics largely patterned after EPA's Rapid Bioassessment Protocols and Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) described by Rankin (1989), Plafkin *et al.* (1989), and Platts *et al.* (1983) in the designated 75 m length of the stream segments; riparian habitat measurements were based on the surrounding area within 50 m of the stream. Other qualitative measurements included (1) aesthetic value, based on evidence of human refuse; (2) remoteness, based on the absence of detectable human activity and difficulty in accessing the segment; (3) land use, based on the surrounding area immediately visible from the segment; (4) general stream character, based on the shape, substrate, and vegetation of the segment; and (5) bank erosion, based on the kind and extent of erosion present. Quantitative measurements at each segment included flow, depth, wetted width, and stream gradient.

Fish and herpetofauna were sampled during the summer index period using quantitative, double-pass electrofishing of the 75 m stream segments. Blocking nets were placed at each end of the segment, and one or more direct-current, backpack electrofishing units were used to sample the entire segment. All fish captured during each electrofishing pass were identified, counted, weighed in aggregate, and up to 100 individuals of each species were examined for external anomalies such as lesions and tumors. All gamefish captured were also measured for length. Any amphibians, reptiles, freshwater molluscs, submerged aquatic vegetation either in or near the stream segment were collected and identified.

For all phases of the MBSS, there was a ongoing, documented program of quality assurance/quality control (QA/QC). The QA/QC program used by the MBSS allows for generation of data with known confidence.

STREAMS SAMPLED IN THE NORTH BRANCH POTOMAC BASIN IN 1996 AS PARTOF THE MARYLAND BIOLOGICAL STREAM SURVEY (MBSS) - QUANTITATIVE SAMPLES ONLY

As described in Chapter 3 and Appendix B, MBSS sampling sites were selected randomly from 1:250,000 scale maps. Many very small streams were selected, some with names and some without. Stream names were acquired for the MBSS database from several map sources. Those streams with no names are called unnamed tributaries (UT).

Stream Name	Order	Stream Name	Order
Bear Pen Run (2 sites)	2	Middle Fork Run	2
Big Run	3	Middle Fork Run UT	1
Blackhawk Run	1	Mill Run (2 sites)	2
Blacklick Run	1	Mill Run	3
Blue Lick Run (2 sites)	2	Mill Run UT	1
Braddock Run (2 sites)	3	Mudlick Run	2
Braddock Run UT	1	North Br Of Jennings Run	3
Collier Run	2	Pea Vine Run	2
Collier Run (2 sites)	3	Poplar Lick Run	2
Deep Hollow	2	Potomac R. UT (2 sites)	2
Double Lick Run	1	Potomac R. UT	1
Dry Run	1	Sand Spring Run	3
Elk Lick Run	3	Sand Spring Run UT	1
Evitts Cr.	3	Savage R. (5 sites)	3
Frog Hollow	2	Savage R. (5 sites)	2
Georges Cr. (3 sites)	3	Seven Springs Run (2 sites)	2
Georges Cr. UT	1	Seven Springs Run UT	1
Glade Run	1	Spring Lick	1
Glade Run UT	1	Staub Run	1
Jennings Run UT	2	Three Forks Run	2
Laurel Run	3	Trading Run	3
Laurel Run	2	Warrior Run	1
Laurel Run UT.	2	Wills Cr. UT	1
Lostland Run (3 sites)	3		

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Appendix C: Location (in decimal degrees) and water quality data for MBSS sites in the North Branch Potomac basin, 1996. Temperature and Dissolved Oxygen (DO) were measured in the summer while all other parameters were measured during the spring. Units of measure for temperature are degrees Celcius. DO, nitrate nitrogen (NO_3), sulfate (SO_4), and dissolved organic carbon (DOC) are presented in mg/L, and acid neutralizing capacity (ANC) is measured as µeq/L.

Stream Name	Latitude	Longitude	Temp.	DO	pH	NO_3	SO_4	DOC	ANC
Bear Pen Run	39.5760	79.1211	17.0	7.6	6.79	0.54	13.45	0.9	65.4
Bear Pen Run	39.5692	79.1205	22.0	8.3	6.74	0.57	13.68	1.1	63.6
Big Run	39.5777	79.1674	15.0	8.5	7.06	0.50	11.81	0.9	73.6
Blackhawk Run	39.5497	79.2015	13.0	8.4	6.61	0.83	13.93	0.6	61.1
Blacklick Run	39.6254	79.1007	13.9	7.9	6.58	1.85	14.02	1.1	84.4
Blue Lick Run	39.6342	79.0587	14.3	8.5	7.28	1.20	10.85	1.0	76.1
Blue Lick Run	39.6178	79.0688	13.4	9.4	6.63	0.80	11.54	0.7	98.8
Braddock Run	39.6415	78.8598	15.0	9.4	7.69	0.71	296.74	1.3	1483.7
Braddock Run	39.6379	78.8487	13.0	10.1	7.73	0.59	346.43	0.8	308.7
Braddock Run UT	39.6365	78.8753	17.6	7.7	6.57	1.32	41.68	0.8	85.6
Collier Run	39.6641	78.6599	20.4	7.5	6.79	0.27	9.76	2.4	30.6
Collier Run	39.6052	78.7043	16.0	7.8	6.96	0.30	17.1	2.1	282.7
Collier Run	39.5872	78.7176	18.2	8.6	7.21	0.26	17.63	1.5	560.9
Deep Hollow	39.4831	78.9617	17.0	7.5	6.43	0.79	22	2.0	391.6
Double Lick Run	39.5395	79.2086	13.0	9.0	6.79	0.49	12.89	0.8	55.2
Dry Run	39.4593	78.9877				0.91	31.19	2.2	119.8
Elk Lick Run	39.6775	78.7075	21.0	8.1	7.46	1.04	49.25	1.4	3922.1
Evitts Cr.	39.7008	78.6980	22.5	8.7	7.64	0.69	14.35	2.7	922.3
Frog Hollow	39.5757	78.6873	18.4	8.3	7.32	0.37	27.66	2.3	338.8
Georges Cr.	39.5100	79.0423	15.0	8.7	6.71	0.86	263.14	1.0	518
Georges Cr.	39.5164	79.0213	20.2	8.1	6.97	0.86	235.87	1.1	654.8
Georges Cr.	39.5070	79.0443	15.0	8.7	6.71	0.67	349.54	1.9	678.3
Georges Cr. UT	39.5229	79.0136	17.9	9.3	3.95	1.21	520.27	1.0	-3.4
Glade Run	39.3263	79.3523	18.8	7.7	7.87	0.32	67.06	1.6	861.5
Glade Run UT	39.3234	79.3232	17.8	7.2	6.77	0.42	7.17	1.2	140.2
Jennings Run UT	39.7056	78.8968	16.6	9.0	4.76	0.62	128.98	1.4	-92.2
Laurel Run	39.3413	79.2619	18.0	7.8	7.19	0.40	58.88	1.3	233.4
Laurel Run	39.3623	79.2906	16.0	7.3	6.78	0.36	41.2	1.0	132
Laurel Run UT	39.4754	79.1221	16.7	8.9	6.95	0.53	63.18	1.1	466.1
Lostland Run	39.3637	79.2416	17.5	8.4	7.15	0.35	62.81	1.1	187.9
Lostland Run	39.3619	79.2354	17.0	8.2	7.00	0.35	61.64	1.0	185.1
Lostland Run	39.3619	79.2328	16.6	8.2	6.98	0.36	61.14	1.1	177.8
Middle Fork Run	39.5147	79.1601	20.0	8.5	6.88	0.72	14.05	1.0	66.3
Middle Fork Run UT	39.5263	79.1849	14.2	7.4	6.63	0.74	14.92	1.6	89.6
Mill Run	39.6304	78.6416	21.0	8.9	6.75	0.46	12.98	1.2	232.5
Mill Run	39.5992	78.6548	18.0	8.7	7.13	0.26	26.48	2.2	395.8
Mill Run	39.5461	78.9096	15.2	8.5	7.72	0.68	12.89	1.1	629.4
Mill Run UT	39.5369	78.9180				0.50	13.97	1.5	63.6
Mudlick Run	39.6616	79.0286	21.0	7.4	6.51	0.84	16.3	1.0	245.4
North Br. Jennings Run	39.7020	78.8449	18.6	7.7	7.44	1.18	73.51	1.2	515.9
Pea Vine Run	39.7114	78.7191				0.53	19.5	1.9	1334.1
Poplar Lick Run	39.6032	79.1218	17.8	8.1	6.72	0.47	10.75	0.9	111.4
Potomac R. UT	39.5803	78.8472	18.9	7.2	7.62	0.74	23.5	2.1	446.6

Appendix C: Location (in decimal degrees) and water quality data for MBSS sites in the North Branch Potomac basin, 1996. Temperature and Dissolved Oxygen (DO) were measured in the summer while all other parameters were measured during the spring. Units of measure for temperature are degrees Celcius. DO, nitrate nitrogen (NO_3), sulfate (SO_4), and dissolved organic carbon (DOC) are presented in mg/L, and acid neutralizing capacity (ANC) is measured as µeq/L.

Stream Name	Latitude	Longitude	Temp.	DO	pH	NO_3	SO_4	DOC	ANC
Potomac R. UT	39.5884	78.8539	16.0	7.9	7.56	0.68	13.86	1.7	140.6
Potomac R. UT	39.5829	78.8312	16.6	8.2	8.19	2.46	37.01	2.3	3503.9
Sand Spring Run	39.6546	78.9403	19.0	7.4	7.21	0.80	22.08	2.4	175.7
Sand Spring Run UT	39.6708	78.9549	15.0	7.5	4.85	0.62	25.54	1.6	-12.7
Savage R.	39.6365	79.0295	18.0	7.6	7.25	0.77	14.10	2.6	160.4
Savage R.	39.6597	79.0014	18.0	7.2	6.82	0.76	15.61	3.6	183.2
Savage R.	39.6401	79.0238	21.1	7.9	6.89	0.74	13.22	2.9	158.6
Savage R.	39.5540	79.1212	19.0	7.8	6.76	0.80	12.03	1.5	88.4
Savage R.	39.6135	79.0472	17.0	8.9	5.96	0.58	11.81	2.1	135.2
Savage R.	39.5792	79.0945	21.4	7.7	6.95	0.63	12.28	1.4	140.6
Seven Springs Run	39.5627	78.6318	18.0	6.0	6.90	0.30	28.98	3.3	475.2
Seven Springs Run	39.5605	78.6242				0.18	36.00	2.7	1163
Seven Springs Run UT	39.5633	78.6307				0.17	27.12	2.1	1651.3
Spring Lick	39.4949	79.1817	14.4	9.1	7.47	0.68	13.86	1.1	149
Staub Run	39.6329	78.9770	14.0	8.1	4.72	0.31	7.75	1.1	-10.5
Three Forks Run	39.4125	79.1679	14.8	9.3	3.36	0.50	160.58	0.8	-319.7
Trading Run	39.5585	78.6186	24.2	8.1	6.80	0.33	24.63	2.9	327.8
Warrior Run	39.5989	78.8563	15.0	8.2	7.39	1.11	44.96	1.1	343.1
Wills Cr. UT	39.7128	78.7701	19.8	8.9	7.90	2.76	42.97	1.7	2622

PHYSICAL HABITAT CONDITIONS MEASURED BY THE MBSS

- All variables rated on a scale of 0 (poor) to 20 (optimal) unless otherwise noted. -

I. SUBSTRATE AND INSTREAM COVER

Instream Habitat is rated according to the perceived value of habitat to the fish community. Higher scores are assigned to sites with a variety of habitat types and particle sizes. In addition, higher scores are assigned to sites with a high degree of uneven substrate, including logs and rootwads. In streams where substrate types are favorable but flows are so low that fish are essentially precluded from using the habitat, low scores are assigned. If none of the habitat within a segment is useable by fish, a score of zero is assigned.

Epifaunal Substrate is rated based on the amount and variety of hard, stable substrates usable by benthic macroinvertebrates. Because they inhibit colonization, flocculent materials or fine sediments surrounding otherwise good substrates are assigned low scores. Scores are also reduced when substrates are less stable.

Velocity/Depth Diversity is rated based on the variety of velocity/depth regimes present at a site (slow-shallow, slow-deep, fast-shallow, and fast-deep). As with embeddedness, this metric varies by stream gradient.

Pool/Glide/Eddy Quality is rated based on the variety and spatial complexity of slow or still water habitat within the sample segment. In high-gradient streams, functionally important slow water habitat may exist in the form of larger eddies. Within a category, higher scores are assigned to segments which have undercut banks, woody debris or other types of cover for fish.

Riffle/Run Quality is based on the depth, complexity, and functional importance of riffle/run habitat in the segment, with highest scores assigned to segments dominated by deeper riffle/run areas, stable substrates, and a variety of current velocities.

Embeddedness is a percentage of surface area of larger particles that is surrounded by fine sediments on the stream bottom. In low gradient streams, embeddedness may be high even in relatively unimpaired watersheds.

II. CHANNEL CHARACTER

Channel Alteration is a measure of large-scale changes in the shape of the stream channel. Channel alteration includes: concrete channels, artificial embankments, obvious straightening of the natural channel, rip-rap, or other structures, as well as recent bar development. Ratings for this metric are based on the presence of artificial structures as well as the existence, extent, and coarseness of point bars, side bars, and mid-channel bars which indicate the degree of flow fluctuations and substrate stability. Evidence of channelization may sometimes be seen in the form of berms which parallel the stream channel.

Bank Stability is rated based on the presence/absence of riparian vegetation and other stabilizing bank materials such as boulders and rootwads, and frequency/size of erosional areas. Sites with steep slopes are not penalized if banks are composed solely of stable materials.

Channel Flow Status is the percentage of the stream channel that has water, with subtractions made for exposed substrates and dewatered areas.

III. RIPARIAN CORRIDOR

Shading is rated based on estimates of the degree and duration of shading at a site during summer, including any effects of shading caused by land forms.

Riparian Buffer is rated according to the size and type of the vegetated riparian buffer zone at the site. Cultivated fields for agriculture which have bare soil to any extent are not considered as riparian buffers. At sites where the buffer width is variable or direct delivery of storm runoff or sediment to the stream is evident or highly likely, the narrowest representative buffer width in the segment (e.g., 0 if parking lot runoff enters directly to the stream) is measured and recorded even though some of the stream segment may have a well developed riparian buffer.

IV. AESTHETICS/REMOTENESS

Aesthetics are rated according to the visual appeal of the site and presence/absence of human refuse, with highest scores assigned to stream segments with no human refuse and visually outstanding character.

Remoteness is rated based on the absence of detectable human activity and difficulty in accessing the segment.

Appendix D: Location and physical habitat data for MBSS sites in the North Branch Potomac basin, 1996. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Latitude	Longitude	Instream Habitat	Epifaunal Substrate	Velocity/ Depth	Pool Quality	Riffle Quality
Bear Pen Run	39.5760	79.1211	17	18	10	12	12
Bear Pen Run	39.5692	79.1205	17	18	10	16	13
Big Run	39.5777	79.1674	16	16	12	11	14
Blackhawk Run	39.5497	79.2015	11	11	7	6	7
Blacklick Run	39.6254	79.1007	15	11	10	11	15
Blue Lick Run	39.6342	79.0587	18	19	10	16	18
Blue Lick Run	39.6178	79.0688	18	17	15	17	19
Braddock Run	39.6415	78.8598	18	3	19	17	2
Braddock Run	39.6379	78.8487	18	3	18	20	20
Braddock Run UT	39.6365	78.8753	6	6	5	6	6
Collier Run	39.6641	78.6599	11	5	6	12	11
Collier Run	39.6052	78.7043	15	15	8	10	10
Collier Run	39.5872	78.7176	14	11	10	12	16
Deep Hollow	39.4831	78.9617	9	5	11	16	7
Double Lick Run	39.5395	79.2086	13	12	9	7	11
Elk Lick Run	39.6775	78.7075	16	4	14	15	7
Evitts Cr.	39.7008	78.6980	16	18	7	12	15
Frog Hollow	39.5757	78.6873	9	5	8	10	8
Georges Cr.	39.5100	79.0423	16	11	11	17	15
Georges Cr.	39.5164	79.0213	16	5	16	16	5
Georges Cr.	39.5070	79.0443	19	10	16	18	19
Georges Cr. UT	39.5229	79.0136	12	2	10	11	13
Glade Run	39.3263	79.3523	4	2	7	10	6
Glade Run UT	39.3234	79.3232	6	2	6	5	2
Jennings Run UT	39.7056	78.8968	16	1	13	16	5
Laurel Run	39.3413	79.2619	8	6	12	14	11
Laurel Run	39.3623	79.2906	14	5	17	18	13
Laurel Run UT	39.4754	79.1221	16	15	13	16	15
Lostland Run	39.3637	79.2416	17	8	15	18	16
Lostland Run	39.3619	79.2354	16	6	15	17	5
Lostland Run	39.3619	79.2328	19	10	15	19	18
Middle Fork Run	39.5147	79.1601	18	7	13	16	11
Middle Fork Run UT	39.5263	79.1849	6	16	6	5	4
Mill Run	39.6304	78.6416	11	15	11	14	14
Mill Run	39.5992	78.6548	12	12	10	14	13
Mill Run	39.5461	78.9096	15	10	14	15	12
Mudlick Run	39.6616	79.0286	15	12	12	11	9
North Br. Jennings Run	39.7020	78.8449	11	7	9	9	5
Poplar Lick Run	39.6032	79.1218	16	17	7	14	15
Potomac R. UT	39.5803	78.8472	11	16	7	7	12
Potomac R. UT	39.5884	78.8539	13	16	11	15	10
Potomac R. UT	39.5829	78.8312	14	5	9	12	10
Sand Spring Run	39.6546	78.9403	18	10	13	16	14
Sand Spring Run U.T.	39.6708	78.9549	9	1	11	15	4
Savage R.	39.6365	79.0295	15	4	11	16	16

Appendix D: Location and physical habitat data for MBSS sites in the North Branch Potomac basin, 1996. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Latitude	Longitude	Instream Habitat	Epifaunal Substrate	Velocity/ Depth	Pool Quality	Riffle Quality
Savage R.	39.6597	79.0014	16	3	13	15	16
Savage R.	39.6401	79.0238	15	5	13	17	17
Savage R.	39.5540	79.1212	16	16	13	15	16
Savage R.	39.6135	79.0472	18	12	15	16	16
Savage R.	39.5792	79.0945	15	16	13	10	16
Seven Springs Run	39.5627	78.6318	9	15	8	8	7
Spring Lick	39.4949	79.1817	16	16	10	12	9
Staub Run	39.6329	78.9770	11	8	8	9	9
Three Forks Run	39.4125	79.1679	17	0	12	16	2
Trading Run	39.5585	78.6186	12	5	14	16	8
Warrior Run	39.5989	78.8563	13	17	10	11	16
Wills Cr. UT	39.7128	78.7701	6	11	8	7	7

Appendix D: Location and physical habitat data for MBSS sites in the North Branch Potomac basin, 1996. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Latitude	Longitude	Channel Alteration	Bank Stability	Percent Embeddedness	Channel Flow (%)	Percent Shading
Bear Pen Run	39.5760	79.1211	10	16	45	75	90
Bear Pen Run	39.5692	79.1205	9	18	50	75	77
Big Run	39.5777	79.1674	8	16	25	80	85
Blackhawk Run	39.5497	79.2015	6	16	50	45	95
Blacklick Run	39.6254	79.1007	18	18	40	55	97
Blue Lick Run	39.6342	79.0587	17	17	25	90	88
Blue Lick Run	39.6178	79.0688	16	18	50	94	75
Braddock Run	39.6415	78.8598	15	14	65	98	90
Braddock Run	39.6379	78.8487	5	17	60	98	60
Braddock Run UT	39.6365	78.8753	18	19	45	45	97
Collier Run	39.6641	78.6599	10	13	45	65	80
Collier Run	39.6052	78.7043	9	17	0	94	97
Collier Run	39.5872	78.7176	15	17	0	96	50
Deep Hollow	39.4831	78.9617	10	17	25	40	93
Double Lick Run	39.5395	79.2086	15	17	40	65	90
Elk Lick Run	39.6775	78.7075	18	16	55	65	80
Evitts Cr.	39.7008	78.6980	19	19	25	100	35
Frog Hollow	39.5757	78.6873	6	16	0	95	70
Georges Cr.	39.5100	79.0423	11	17	80	95	25
Georges Cr.	39.5164	79.0213	4	16	70	75	60
Georges Cr.	39.5070	79.0443	1	17	55	90	15
Georges Cr. UT	39.5229	79.0136	9	9	60	70	90
Glade Run	39.3263	79.3523	6	5	75	95	96
Glade Run UT	39.3234	79.3232	2	15	75	80	85
Jennings Run UT	39.7056	78.8968	13	12	75	75	90
Laurel Run	39.3413	79.2619	19	18	0	35	90
Laurel Run	39.3623	79.2906	19	16	60	98	30
Laurel Run UT	39.4754	79.1221	12	19	60	95	92
Lostland Run	39.3637	79.2416	15	19	0	85	80
Lostland Run	39.3619	79.2354	17	18	0	80	75
Lostland Run	39.3619	79.2328	17	19	60	80	40
Middle Fork Run	39.5147	79.1601	14	18	0	60	65
Middle Fork Run UT	39.5263	79.1849	16	19	25	30	85
Mill Run	39.6304	78.6416	6	17	35	65	90
Mill Run	39.5992	78.6548	10	11	65	96	95
Mill Run	39.5461	78.9096	19	18	0	90	95
Mudlick Run	39.6616	79.0286	7	15	35	65	97
North Br. Jennings Run	39.7020	78.8449	15	12	0	75	80
Poplar Lick Run	39.6032	79.1218	14	17	35	96	92
Potomac R. UT	39.5803	78.8472	1	13	40	65	50
Potomac R. UT	39.5884	78.8539	15	18	45	45	96
Potomac R. UT	39.5829	78.8312	11	15	60	70	92
Sand Spring Run	39.6546	78.9403	13	18	60	100	85
Sand Spring Run UT	39.6708	78.9549	1	18	75	90	97
Savage R.	39.6365	79.0295	18	17	0	97	40

Appendix D: Location and physical habitat data for MBSS sites in the North Branch Potomac basin, 1996. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Latitude	Longitude	Channel Alteration	Bank Stability	Percent Embeddedness	Channel Flow (%)	Percent Shading
Savage R.	39.6597	79.0014	10	12	45	85	90
Savage R	39.6401	79.0238	19	19	0	97	45
Savage R.	39.5540	79.1212	18	17	25	50	40
Savage R.	39.6135	79.0472	16	18	40	95	45
Savage R.	39.5792	79.0945	18	18	30	75	35
Seven Springs Run	39.5627	78.6318	13	16	0	60	95
Spring Lick	39.4949	79.1817	10	18	30	65	50
Staub Run	39.6329	78.9770	18	19	60	70	96
Three Forks Run	39.4125	79.1679	16	18	0	95	80
Trading Run	39.5585	78.6186	12	9	45	97	40
Warrior Run	39.5989	78.8563	16	17	40	80	90
Wills Cr. UT	39.7128	78.7701	14	17	35	60	80

Appendix D: Location and physical habitat data for MBSS sites in the North Branch Potomac basin, 1996. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Latitude	Longitude	Riparian Width (m)	Aesthetic Rating	Max. Depth (cm)	Percent Gradient
Bear Pen Run	39.5760	79.1211	50	19	45	5.5
Bear Pen Run	39.5692	79.1205	50	19	32	3
Big Run	39.5777	79.1674	13	18	42	2.5
Blackhawk Run	39.5497	79.2015	50	20	14	7
Blacklick Run	39.6254	79.1007	50	20	33	4.5
Blue Lick Run	39.6342	79.0587	50	16	46	3
Blue Lick Run	39.6178	79.0688	50	17	82	2
Braddock Run	39.6415	78.8598	15	5	94	2.5
Braddock Run	39.6379	78.8487	0	1	164	2.5
Braddock Run UT	39.6365	78.8753	50	19	38	13.5
Collier Run	39.6641	78.6599	50	16	32	2.5
Collier Run	39.6052	78.7043	50	18	34	2
Collier Run	39.5872	78.7176	0	10	42	1
Deep Hollow	39.4831	78.9617	50	20	50	5
Double Lick Run	39.5395	79.2086	50	20	49	5.5
Elk Lick Run	39.6775	78.7075	13	9	84	1
Evitts Cr.	39.7008	78.6980	0	11	46	1.5
Frog Hollow	39.5757	78.6873	0	7	42	3
Georges Cr.	39.5100	79.0423	11	1	165	0.5
Georges Cr.	39.5164	79.0213	0	2	64	1.5
Georges Cr.	39.5070	79.0443	0	2	106	2.5
Georges Cr. UT	39.5229	79.0136	38	3	48	9.5
Glade Run	39.3263	79.3523	0	15	22	1.5
Glade Run UT.	39.3234	79.3232	0	7	22	1.5
Jennings Run UT	39.7056	78.8968	50	5	52	3
Laurel Run	39.3413	79.2619	5	19	95	4
Laurel Run	39.3623	79.2906	0	13	64	1
Laurel Run UT	39.4754	79.1221	50	20	54	5.5
Lostland Run	39.3637	79.2416	50	20	113	5
Lostland Run	39.3619	79.2354	50	18	102	5.5
Lostland Run	39.3619	79.2328	50	18	134	4.5
Middle Fork Run	39.5147	79.1601	50	19	58	2.5
Middle Fork Run UT	39.5263	79.1849	50	20	21	14
Mill Run	39.6304	78.6416	50	19	82	3
Mill Run	39.5992	78.6548	7	15	46	1
Mill Run	39.5461	78.9096	50	19	90	17.5
Mudlick Run	39.6616	79.0286	50	19	51	1.5
North Br. Jennings Run	39.7020	78.8449	50	14	36	1.5
Poplar Lick Run	39.6032	79.1218	0	20	46	2.5
Potomac R. U.T	39.5803	78.8472	0	2	20	2.5
Potomac R. UT	39.5884	78.8539	50	6	49	8.5
Potomac R. UT	39.5829	78.8312	50	12	38	3.2
Sand Spring Run	39.6546	78.9403	0	5	59	3
Sand Spring Run UT	39.6708	78.9549	50	5	58	3
Savage R.	39.6365	79.0295	50	20	58	0.5

Appendix D: Location and physical habitat data for MBSS sites in the North Branch Potomac basin, 1996. See "Physical Habitat Conditions Measured By The MBSS" for details.

Stream Name	Latitude	Longitude	Riparian Width (m)	Aesthetic Rating	Max. Depth (cm)	Percent Gradient
Savage R.	39.6597	79.0014	50	16	70	1.5
Savage R.	39.6401	79.0238	16	20	62	1
Savage R.	39.5540	79.1212	21	11	60	1
Savage R.	39.6135	79.0472	50	19	89	1.5
Savage R.	39.5792	79.0945	0	10	73	0.5
Seven Springs Run	39.5627	78.6318	2	15	36	2
Spring Lick	39.4949	79.1817	0	16	36	6
Staub Run	39.6329	78.9770	50	20	26	7.5
Three Forks Run	39.4125	79.1679	35	1	59	4.5
Trading Run	39.5585	78.6186	0	7	54	1.5
Warrior Run	39.5989	78.8563	0	16	40	5
Wills Cr. UT	39.7128	78.7701	0	20	16	3.5

ECOLOGY AND DISTRIBUTION OF FISH SPECIES COLLECTED IN THE NORTH POTOMAC BASIN

The species descriptions (Jenkins and Burkhead 1994, Rohde et al. 1994) and distributional maps which follow (Figure E5-E40) include those fish species collected during both random and non-random sampling in the North Branch Potomac basin as part of the 1996 MBSS.

Common Name	*Family*	*Tolerance*	*Feeding Group*	*Map*	*Interesting Facts*
American eel	Eel	Tolerant	Generalist	E-5	Although most of their life is spent in fresh water streams (up to 20 years or more), adults become silver in color and journey to the Sargasso sea to spawn (catadromous).
Blacknose dace	Minnow	Tolerant	Omnivore	E-6	This species is tolerant of a wide range of environmental conditions and pollutants. It is the most abundant stream fish in Maryland.
Bluntnose minnow	Minnow	Tolerant	Omnivore	E-7	As the name implies, this species is characterized by an extremely blunt snout.
Central stoneroller	Minnow	Moderate	Algivore	E-8	Because of its long intestine (up to 8 times its body length), this species is incredibly efficient at digesting detritus and algae.
Common shiner	Minnow	Moderate	Omnivore	E-9	This species often becomes more abundant when cold water streams become stressed by high temperatures.
Creek chub	Minnow	Tolerant	Generalist	E-10	Like other minnow species, this minnow doesn’t have teeth around the jaw. However, it is quite capable of taking large prey items and readily strikes at lures intended for trout.
Cutlips minnow	Minnow	Moderate	Invertivore	E-11	This species is named for the presence of a bony lower jaw bordered on each side by a soft oval lobe.
Fallfish	Minnow	Moderate	Generalist	E-12	The male fallfish may build a large nest of gravel over 3 feet high to protect its mates eggs.
Longnose dace	Minnow	Moderate	Omnivore	E-13	Its streamlined body and large fins allow this minnow to move around easily and remain stationary in fast currents.
River chub	Minnow	Moderate	Omnivore	E-14	During the breeding season, the male develops tubercles on its head and vigorously defends its nest from other males and egg-foraging predators.
Rosyside dace	Minnow	Intolerant	Invertivore	E-15	This minnow is considered to be sensitive to heavy siltation.

Common Name	Family	Tolerance	Feeding Group	Map	Interesting Facts
Spotfin shiner	Minnow	Moderate	Invertivore	E-16	This species occurs in clear streams of moderate gradient and in the shallows of reservoirs and lakes. It is a warmwater species known to form small schools that are occasionally mixed with other minnows.
Creek chubsucker	Sucker	Moderate	Invertivore	E-17	This species lacks a lateral line and therefore is easily distinguishable from other suckers in Maryland.
Golden Redhorse	Sucker	Moderate	Omnivore	E-18	The breeding behavior of males of this species is very aggressive. The males often engage in three fish shoving matches, where one male butts another sideways toward a third, who returns the hammering.
Northern hogsucker	Sucker	Intolerant	Invertivore	E-19	Considered an aggressive feeder, this species has been known to overturn stones and gravel in search of food. Because of its coloration, large schools often go unnoticed.
White sucker	Sucker	Tolerant	Omnivore	E-20	Large white suckers have been reported to reach 17 years of age and lengths of over 23 inches. This is the most widely distributed sucker species in Maryland.
Margined madtom	Catfish	Moderate	Invertivore	E-21	This highly nocturnal species requires hiding places to thrive.The spines of margined madtoms are venomous and can cause considerable pain if handled incorrectly.
Brown bullhead	Catfish	Tolerant	Omnivore	E-22	Although considered native to Maryland, this species has been widely introduced throughout the United Statesto provide fishing opportunities.
Yellow bullhead	Catfish	Tolerant	Omnivore	E-23	Although bullheads are considered bottom feeders, when given the opportunity they are quite capable of catching and eating fish such as minnows and sunfish.
Brook trout	Trout	Intolerant	Generalist	E-24	Commonly found in cold headwater streams, this species is the only trout native to Maryland, and only about 300,000 individuals remain.
Brown trout	Trout	Moderate	Top Predator	E-25	This European species was widely introduced prior to 1900 and has contributed to the widespread decline of brook trout in the eastern United States.
Cutthroat trout	Trout	Moderate	Top Predator	E-26	This native of the western United States was recently introduced to Maryland for sportfishing.
Rainbow trout	Trout	Moderate	Top Predator	E-27	Although ranked among the top five sought after gamefish in North America, hatchery-reared fish are not considered desirable by many fishing purists.

Common Name	*Family*	*Tolerance*	*Feeding Group*	*Map*	*Interesting Facts*
Mottled sculpin	Sculpin	Moderate	Insectivore	E-28	This species is primarily an insectivore and does the majority of its feeding nocturnally. It is the second most abundant stream fish in Maryland.
Potomac sculpin	Sculpin	Moderate	Insectivore	E-29	This sculpin is found only in the Potomac River basin.
Bluegill	Sunfish	Tolerant	Invertivore	E-30	This species has been widely introduced throughout the United States, and has flourished as a result of its tolerance to a variety of conditions.
Green sunfish	Sunfish	Tolerant	Generalist	E-31	This species is intolerant of low pH, but tolerant of many other types of stress. The lowest pH where this sunfish was collected in the basin was 7.1.
Largemouth bass	Sunfish	Moderate	Top Predator	E-32	This species is considered the most popular gamefish in the United States and has been known to reach weights of over 10 pounds in Maryland.
Pumpkinseed	Sunfish	Moderate	Invertivore	E-33	This sunfish is tolerant of darkly-stained acidic waters and is a regular visitor to brackish waters.
Redbreast sunfish	Sunfish	Moderate	Generalist	E-34	Often found with smallmouth bass and other “cool water” species, this sunfish has been found in water warmer than 100^{o} F.
Rock bass	Sunfish	Moderate	Generalist	E-35	This big-mouthed sunfish is an ambush predator that feeds on a wide variety of minnows and aquatic insects.
Smallmouth bass	Sunfish	Moderate	Top Predator	E-36	One reason for this species’ popularity as a gamefish is its aggressive nature and frequent aerial acrobatics when hooked on light tackle.
Fantail darter	Perch	Moderate	Insectivore	E-37	Aided by its small, cone shaped mouth, this insect eater commonly forages in crevices and under rocks.
Greenside darter	Perch	Moderate	Insectivore	E-38	Of the genus *Etheostoma*, the greenside darter is the largest species.
Rainbow darter	Perch	Moderate	Insectivore	E-39	This species is named for its bright red, blue, and green coloration during spawning season.
Yellow perch	Perch	Moderate	Generalist	E-40	The yellow perch population in Chesapeake Bay is unique because it winters in areas of moderate salinity. All other populations spend their entire life cycle in freshwater

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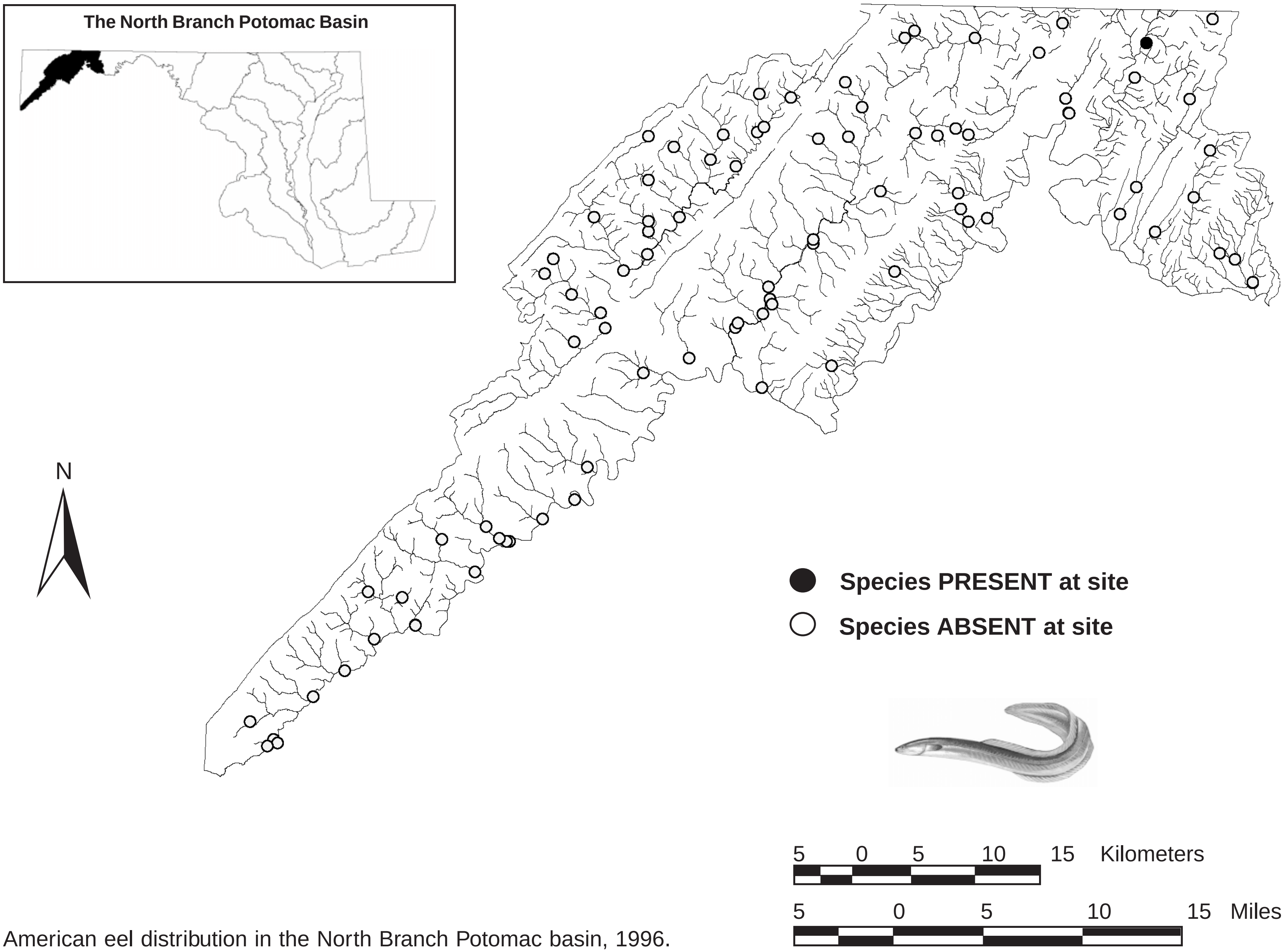
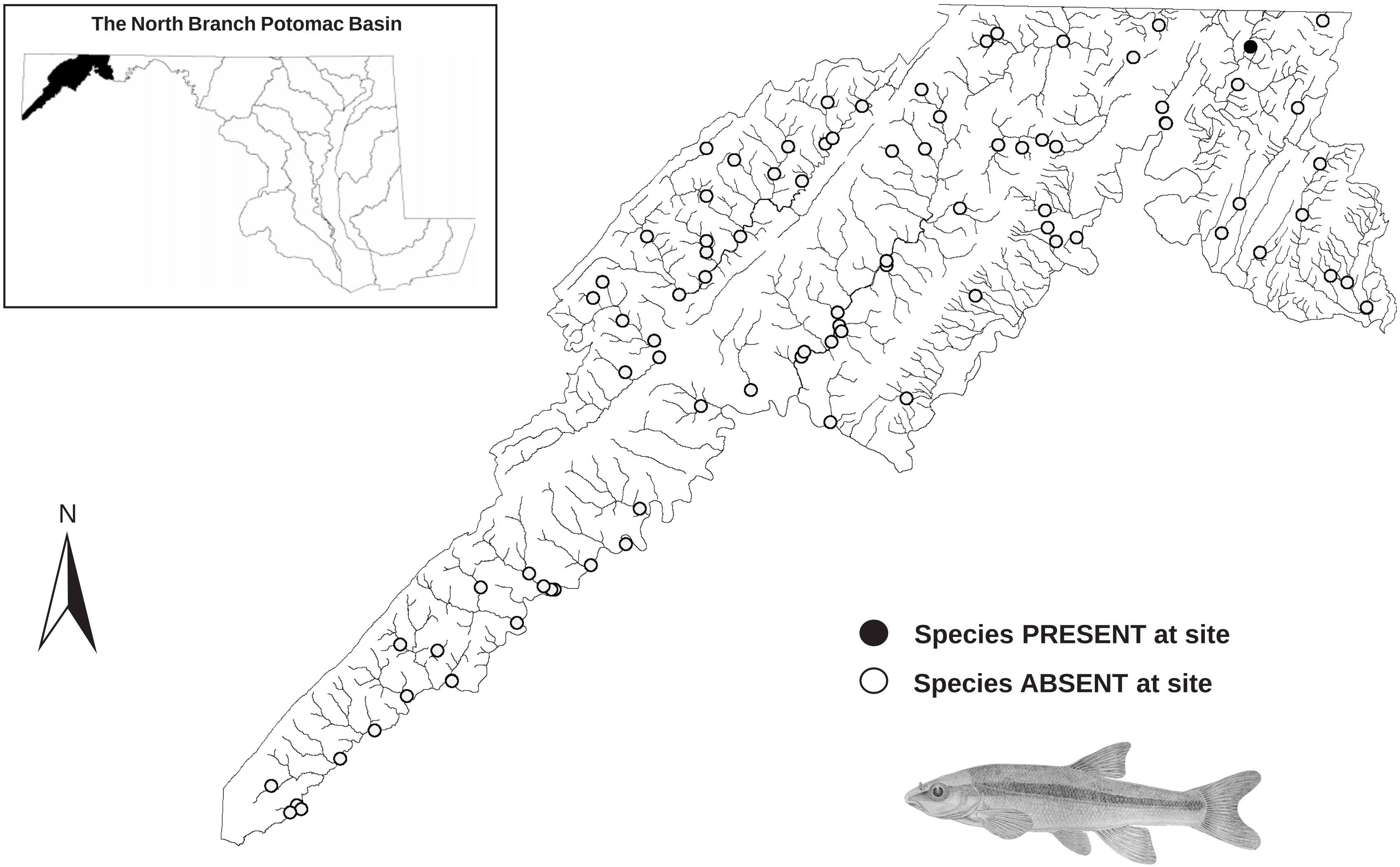
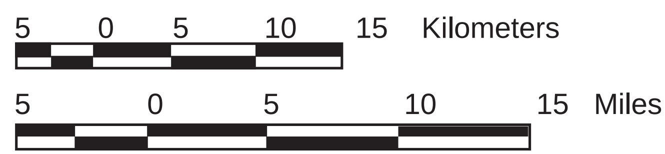
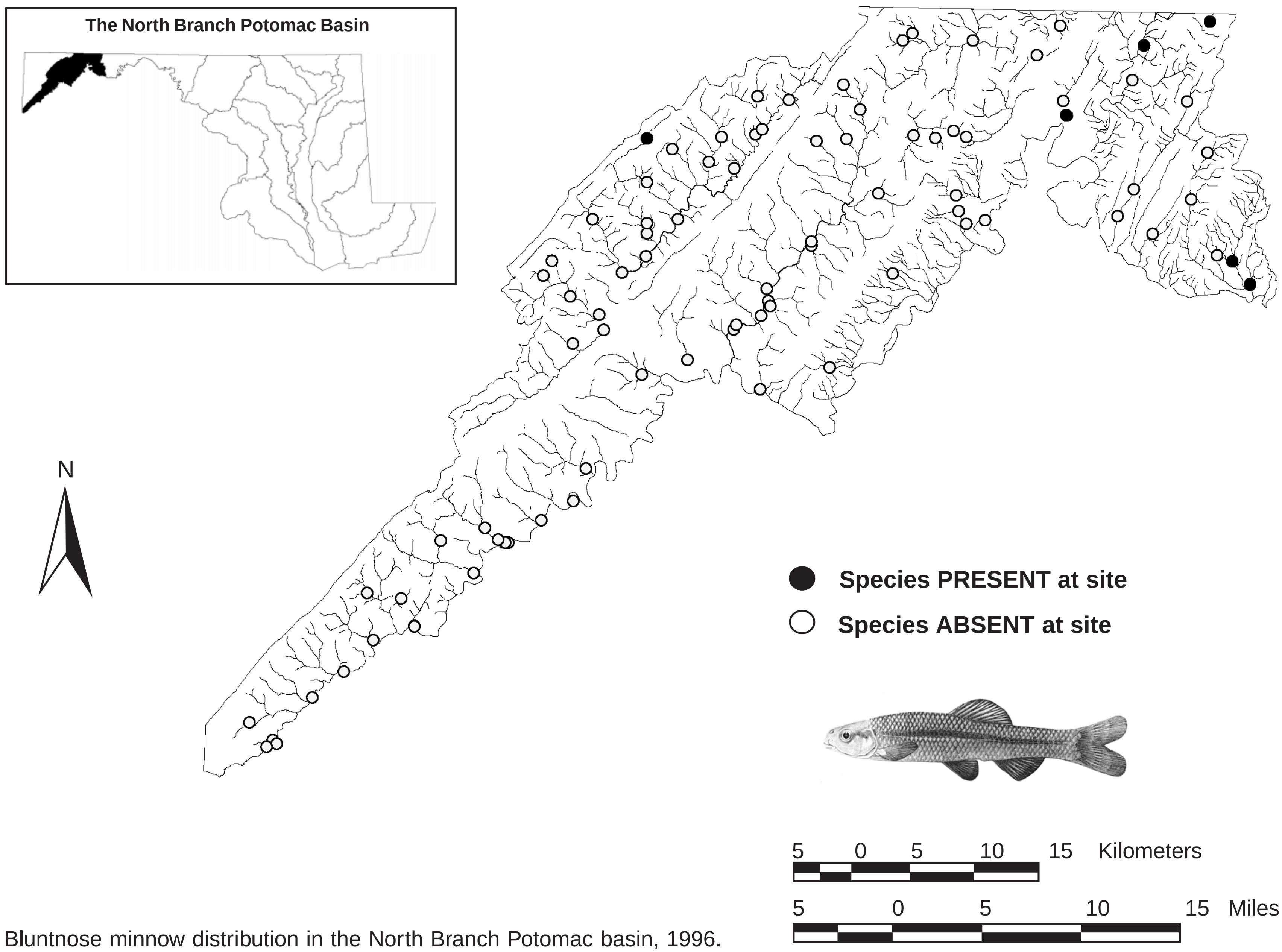


American eel distribution in the North Branch Potomac basin, 1996.

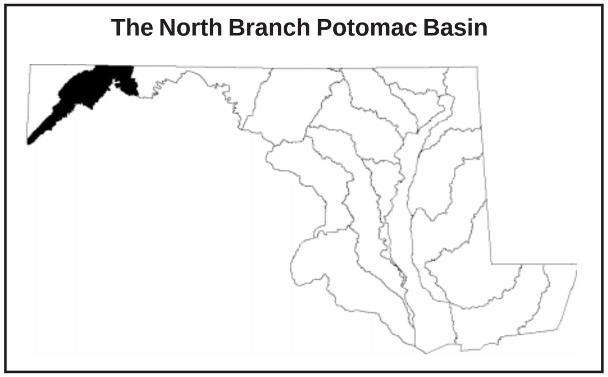


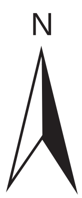


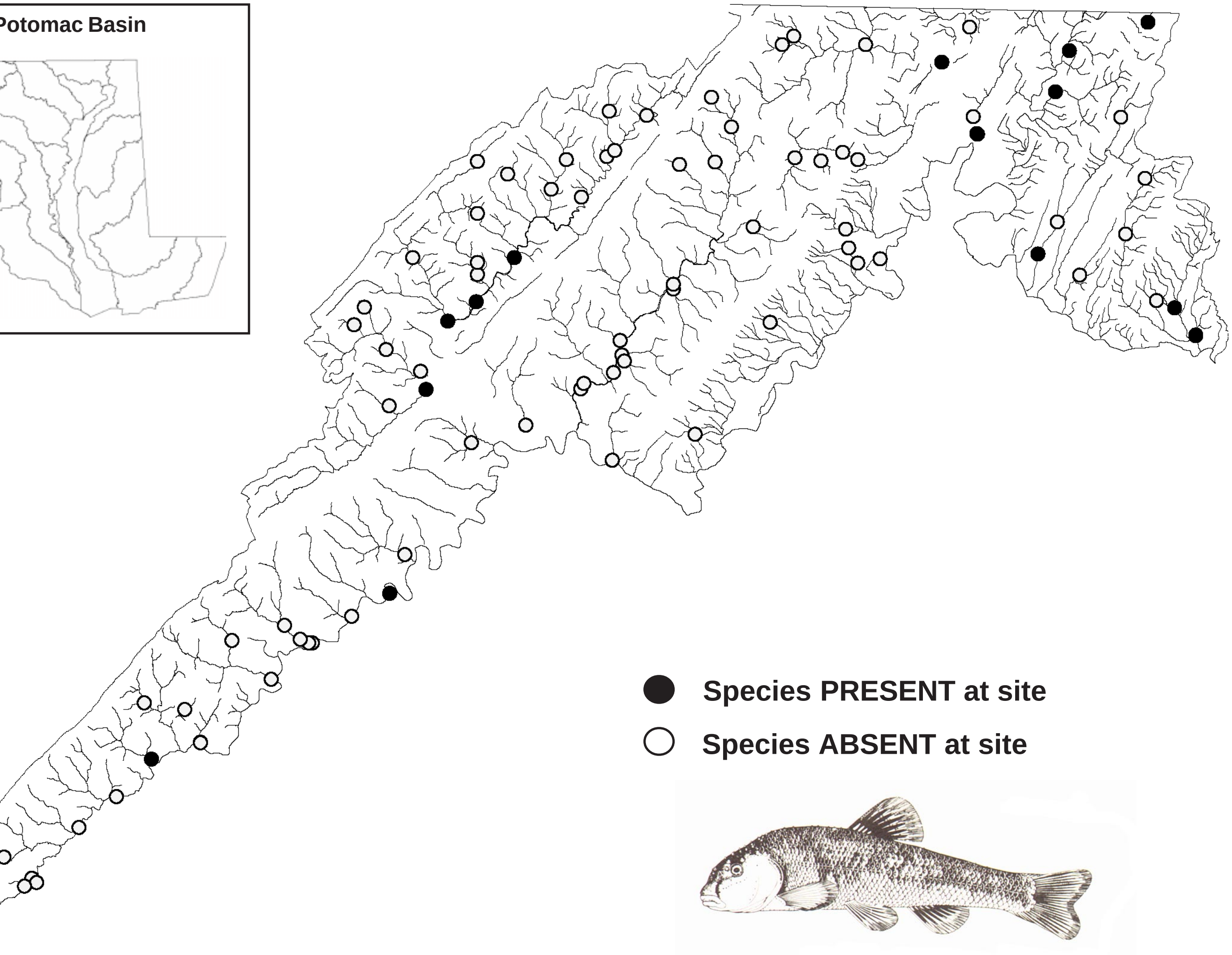
Blacknose dace distribution in the North Branch Potomac basin, 1996.

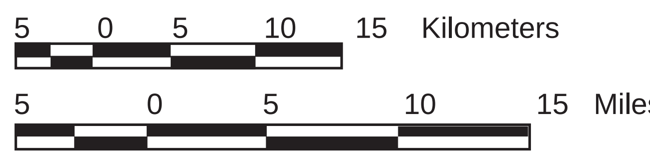


Bluntnose minnow distribution in the North Branch Potomac basin, 1996.

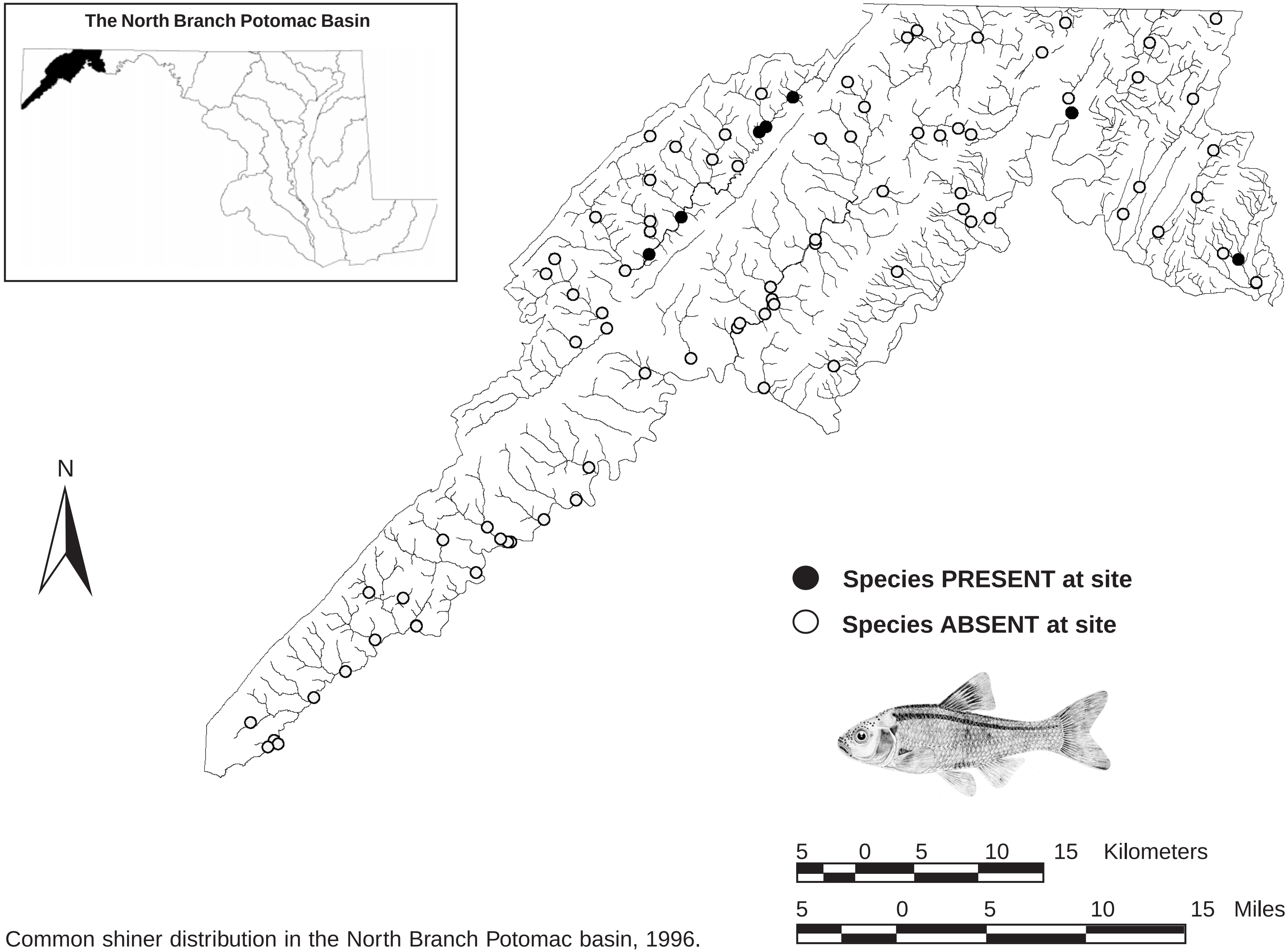




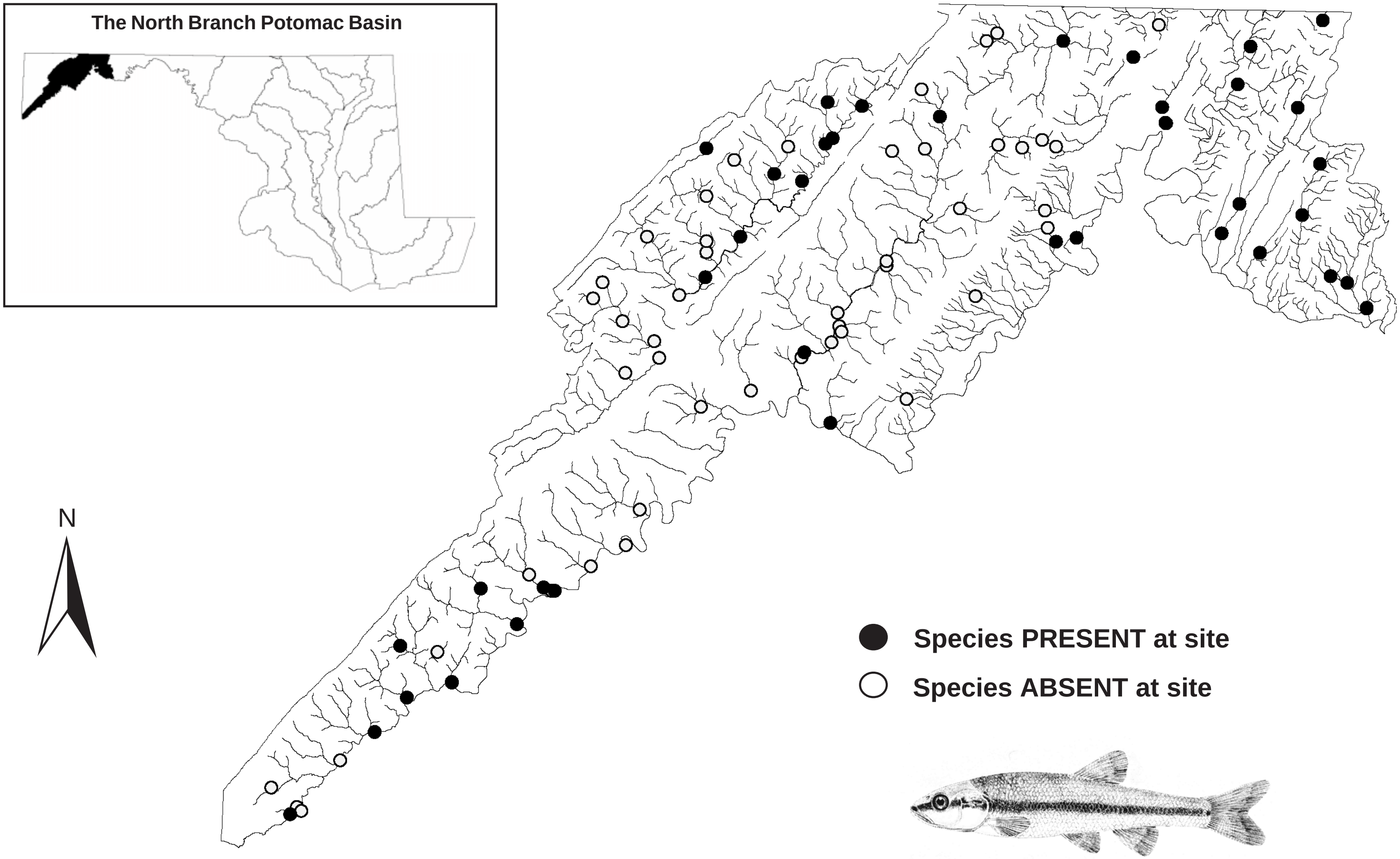


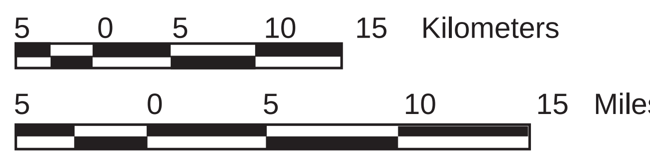


Central stoneroller distribution in the North Branch Potomac basin, 1996.

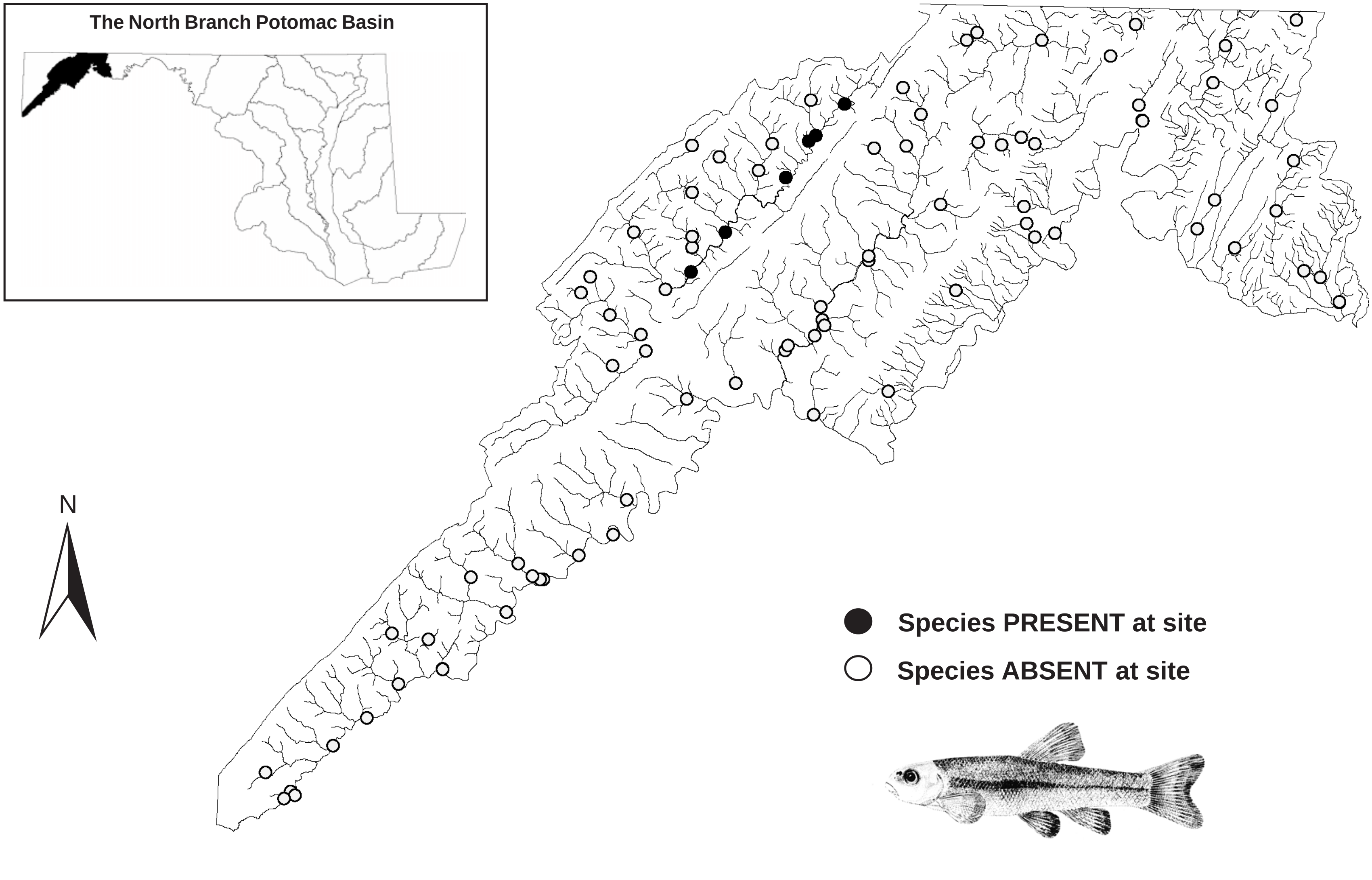


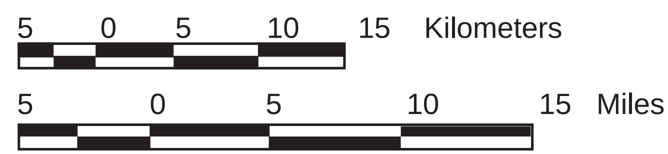
Common shiner distribution in the North Branch Potomac basin, 1996.



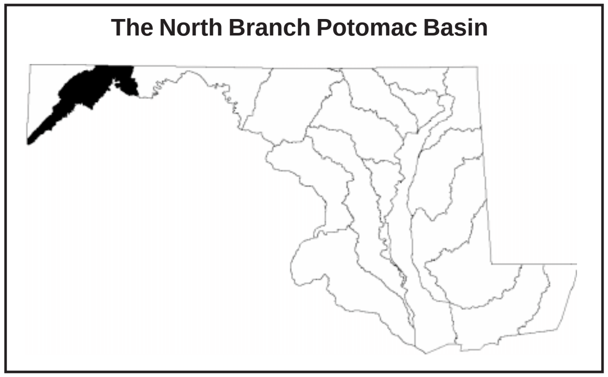


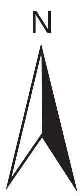
Creek chub distribution in the North Branch Potomac basin, 1996.

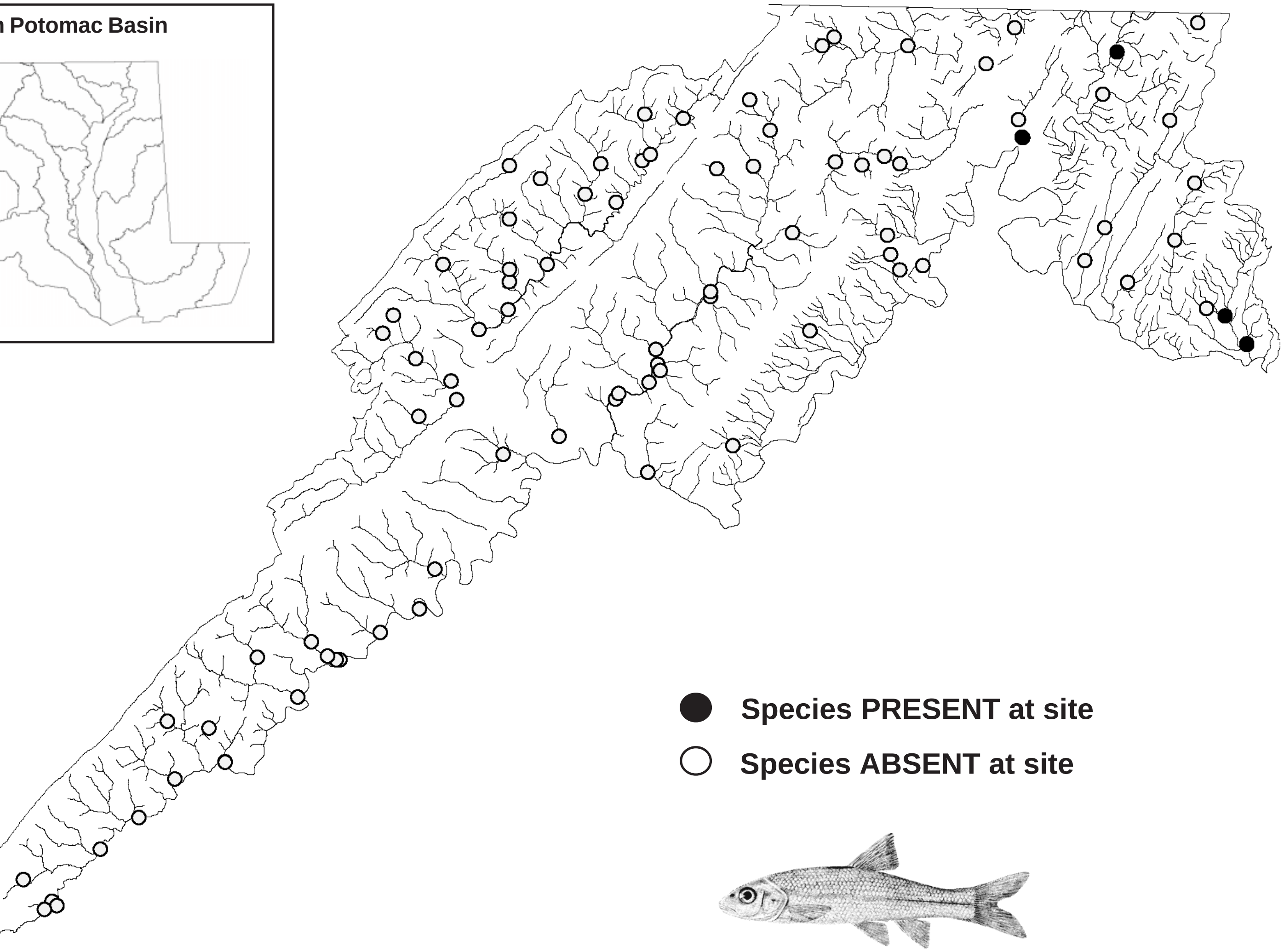


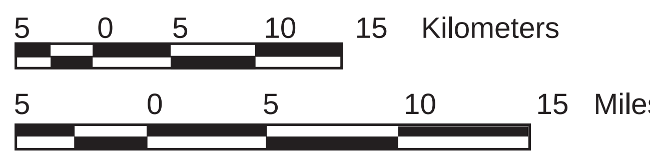


Cutlips minnow distribution in the North Branch Potomac basin, 1996.

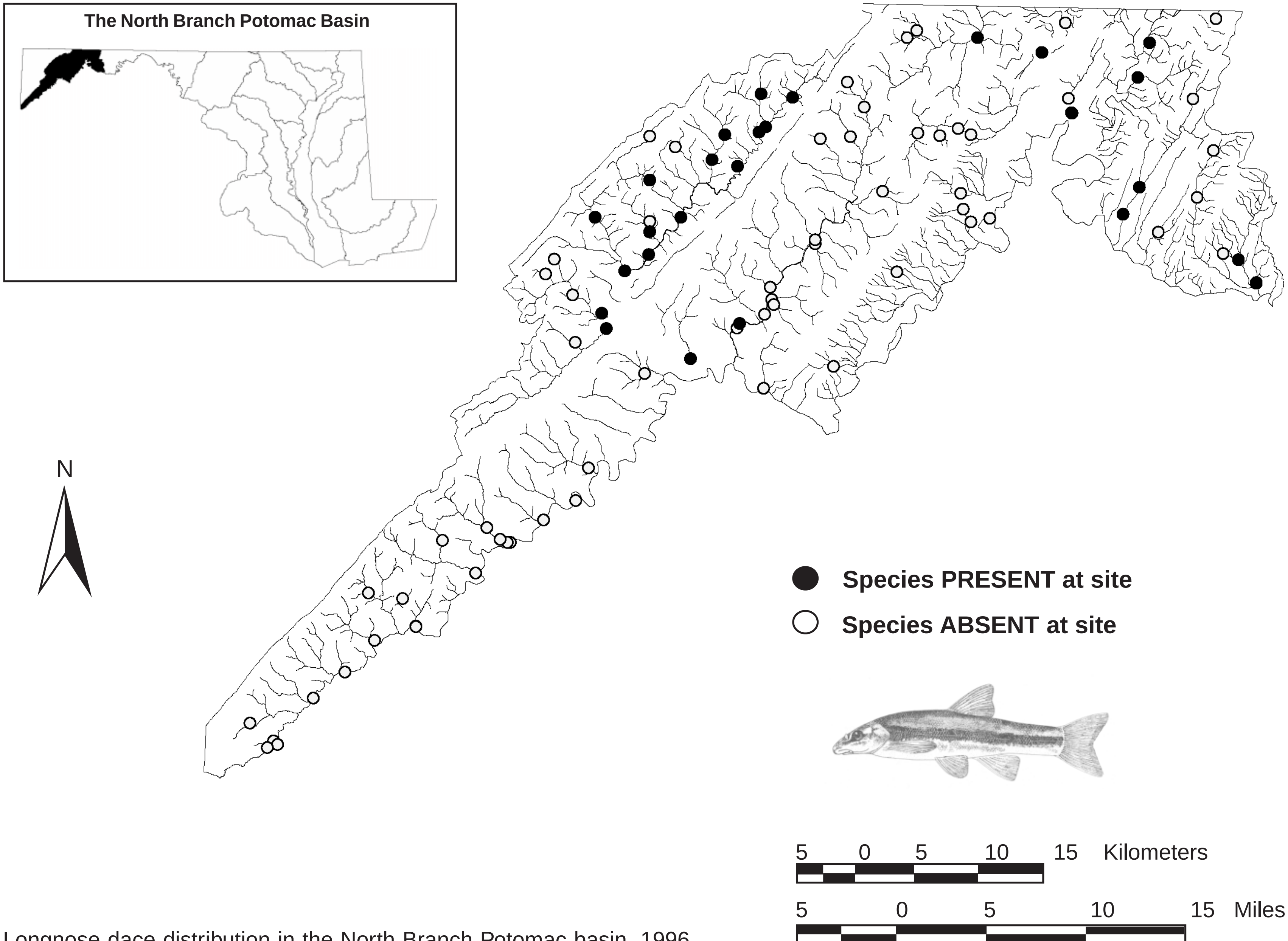




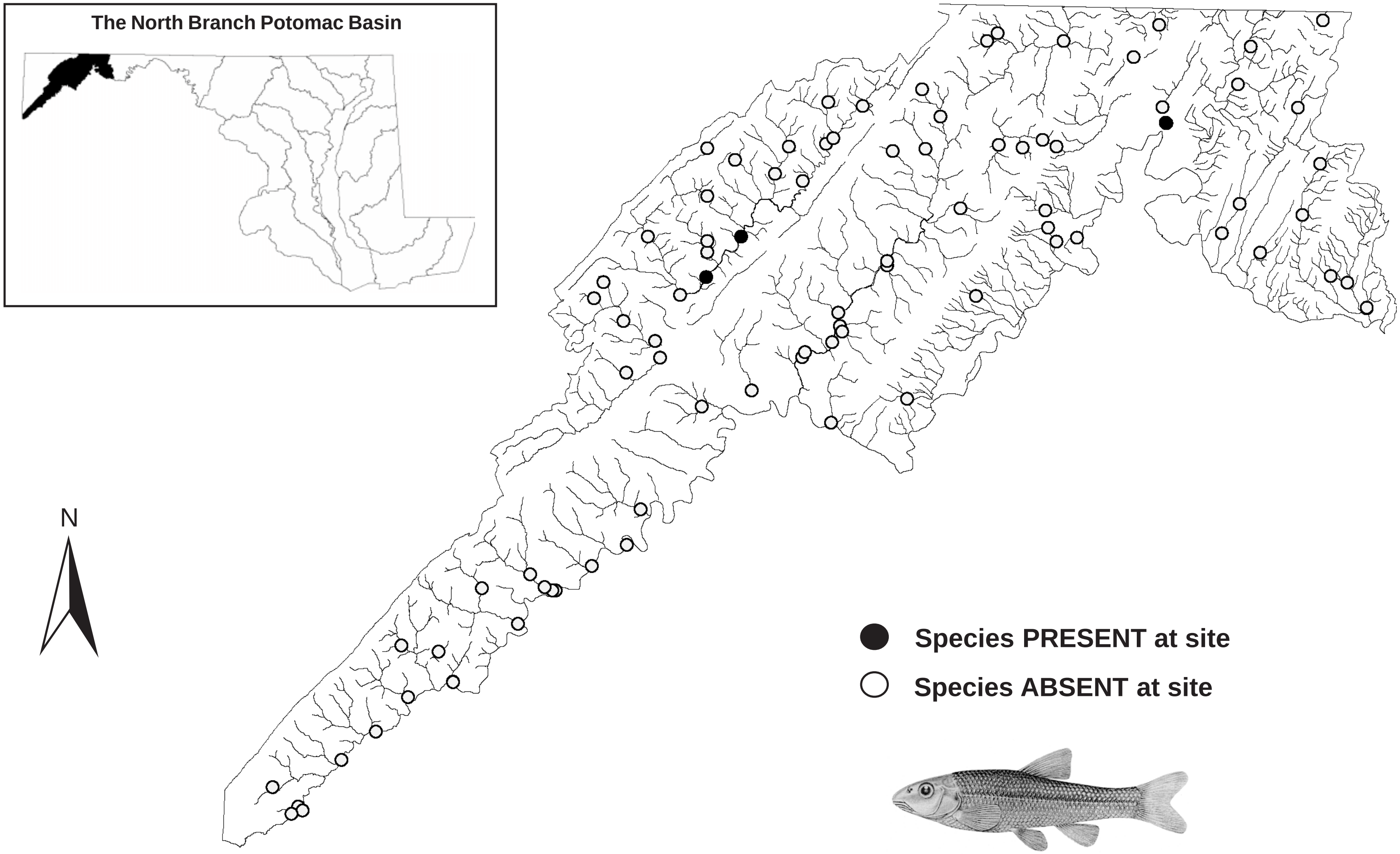


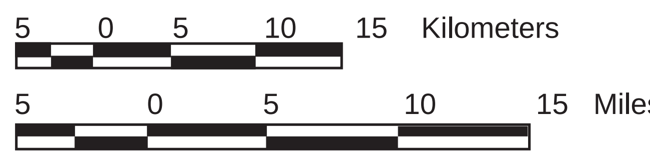


Fallfish distribution in the North Branch Potomac basin, 1996.

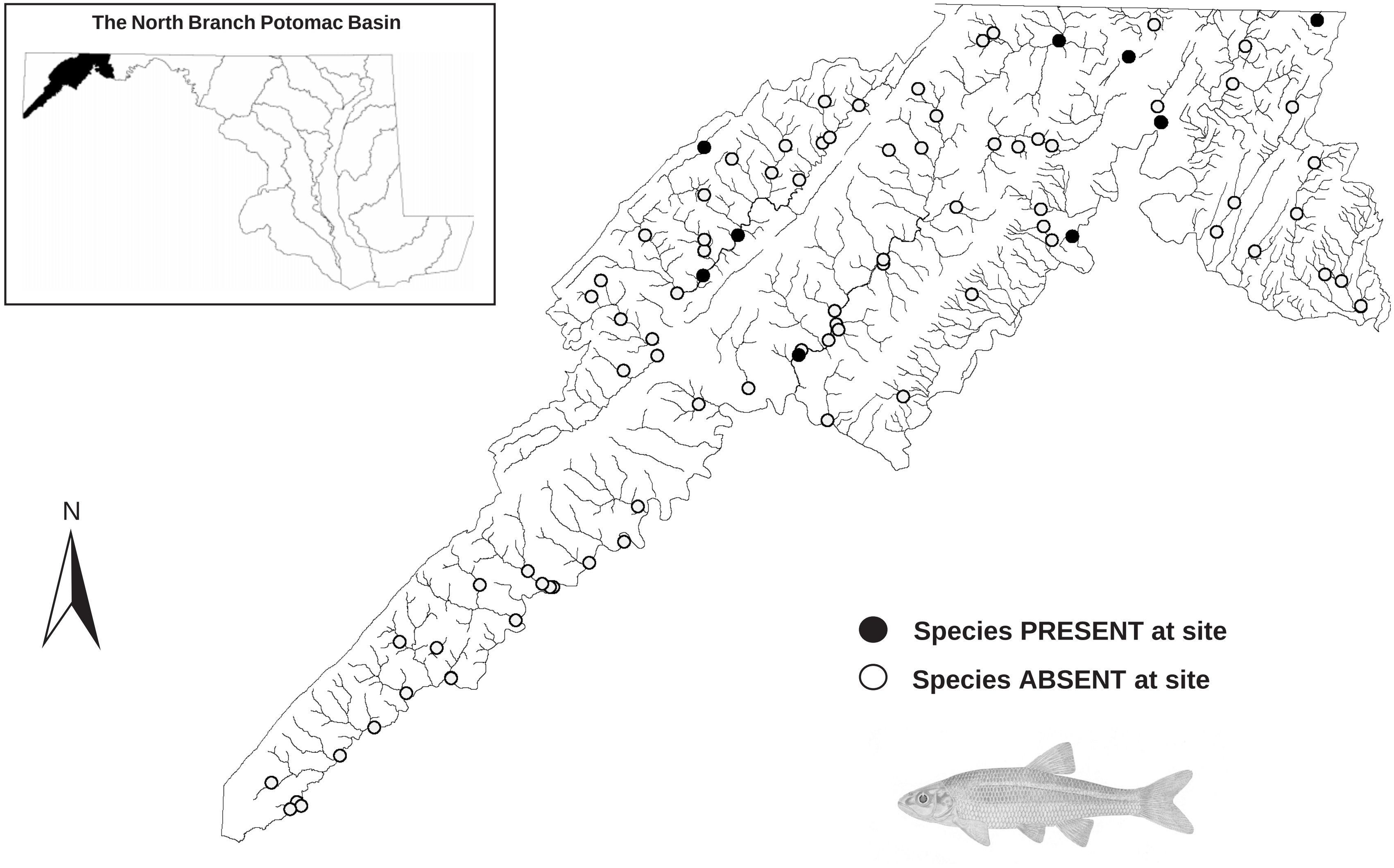


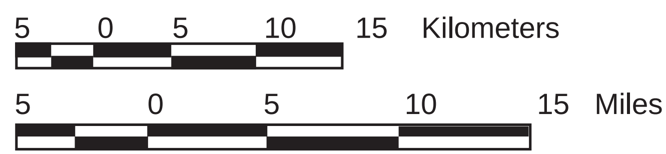
Longnose dace distribution in the North Branch Potomac basin, 1996.



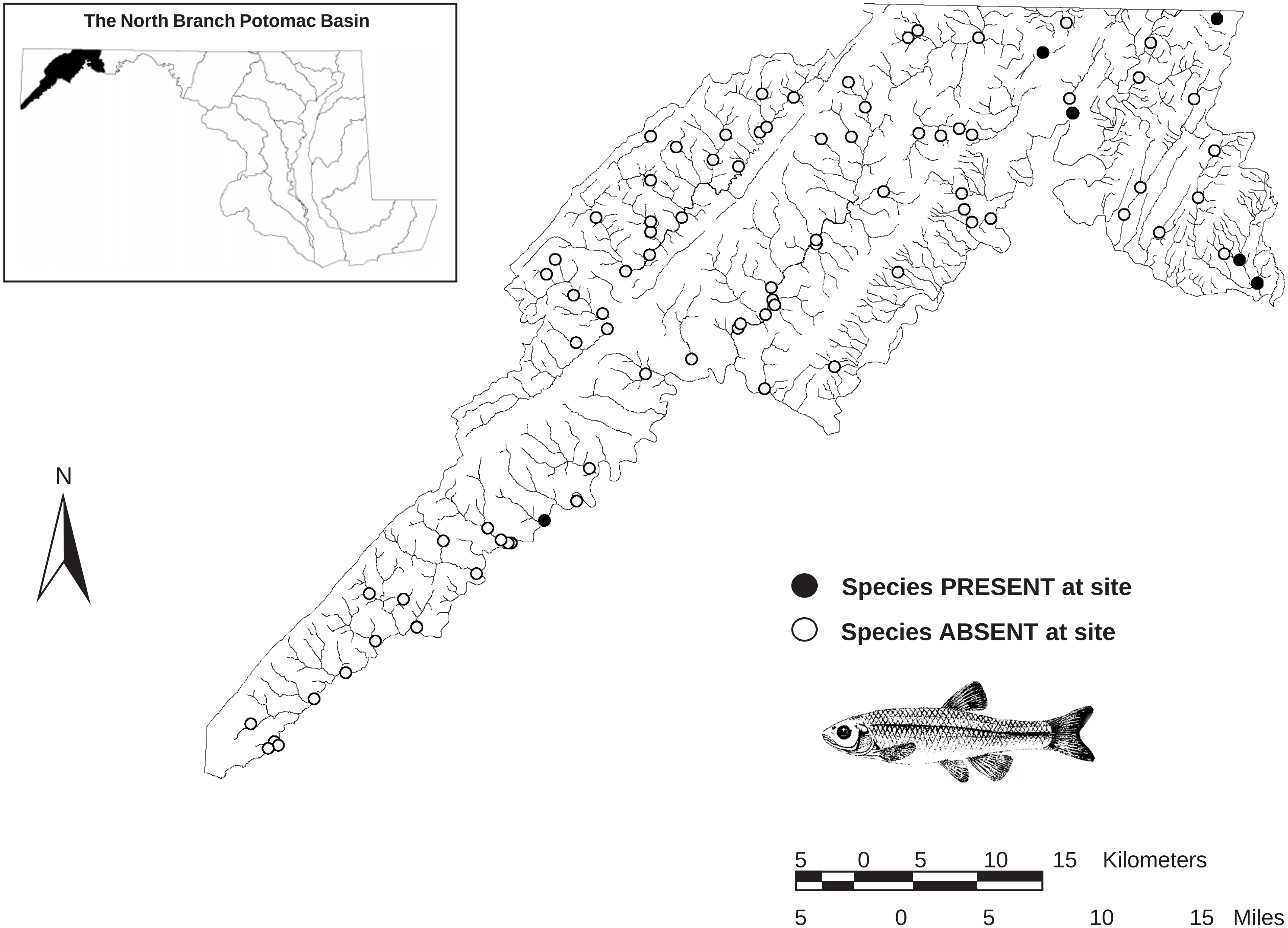


River chub distribution in the North Branch Potomac basin, 1996.

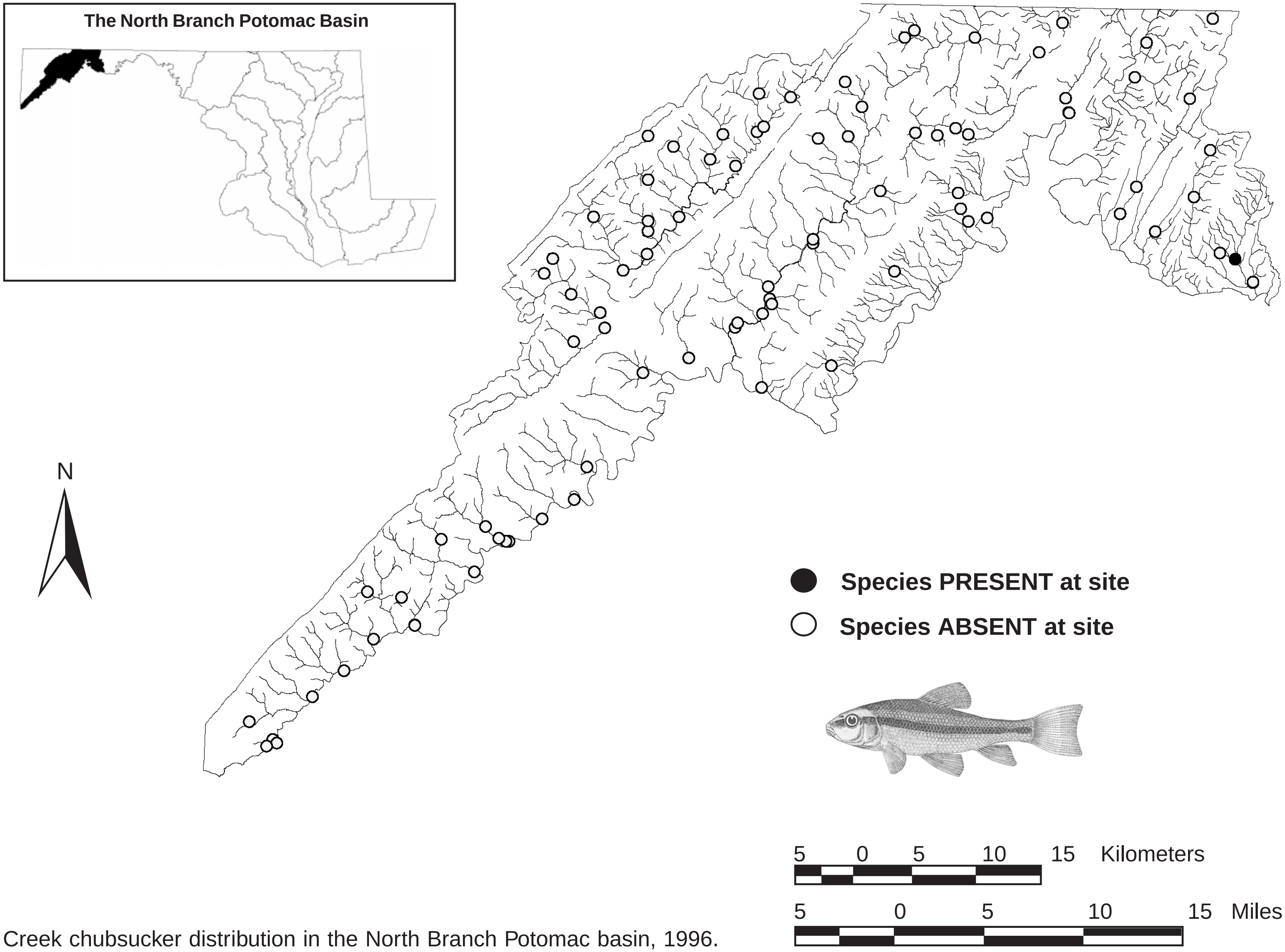




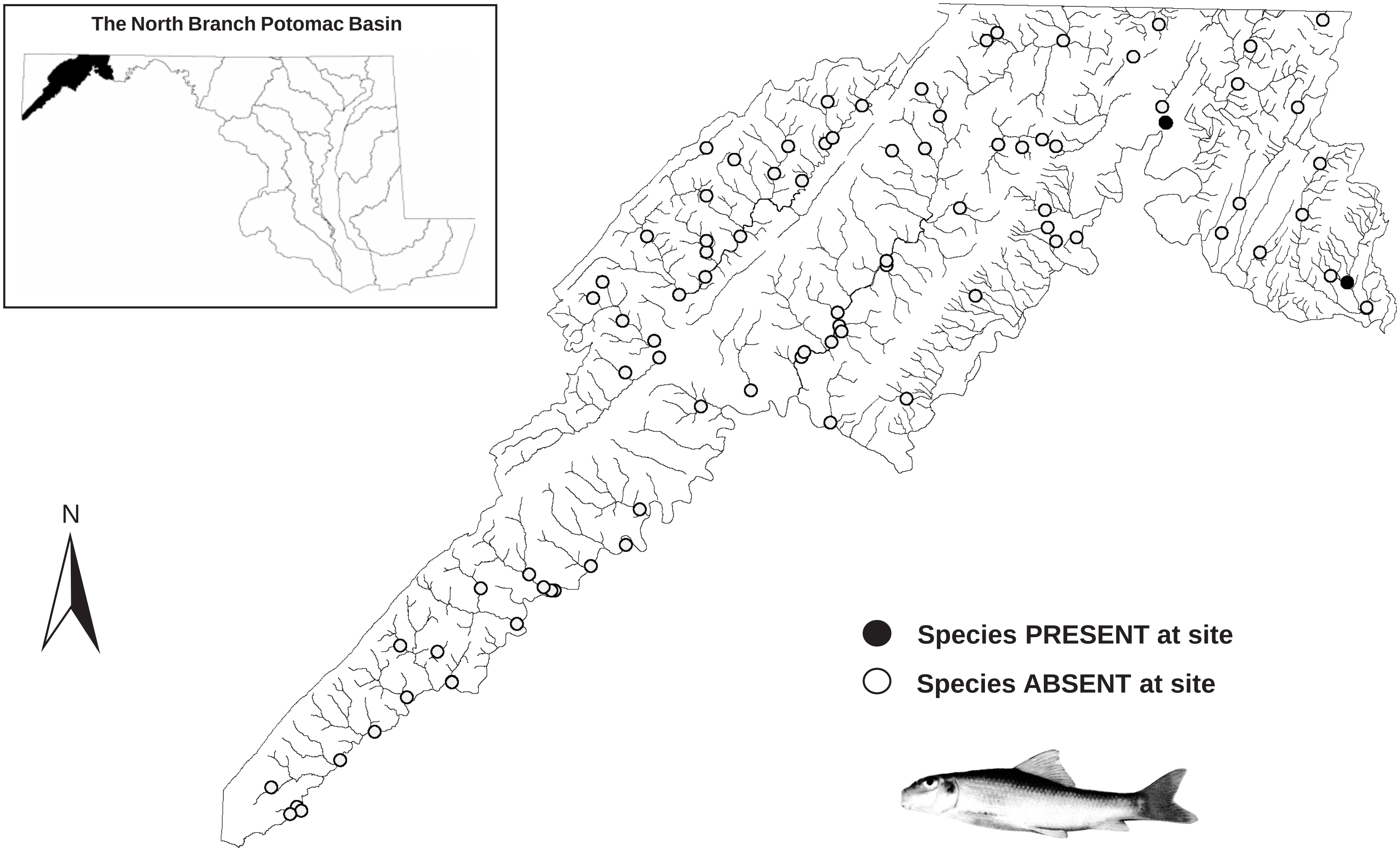
Rosyside dace distribution in the North Branch Potomac basin, 1996.

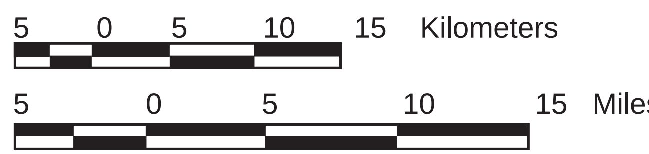


Spotfin shiner distribution in the North Branch Potomac basin, 1996.

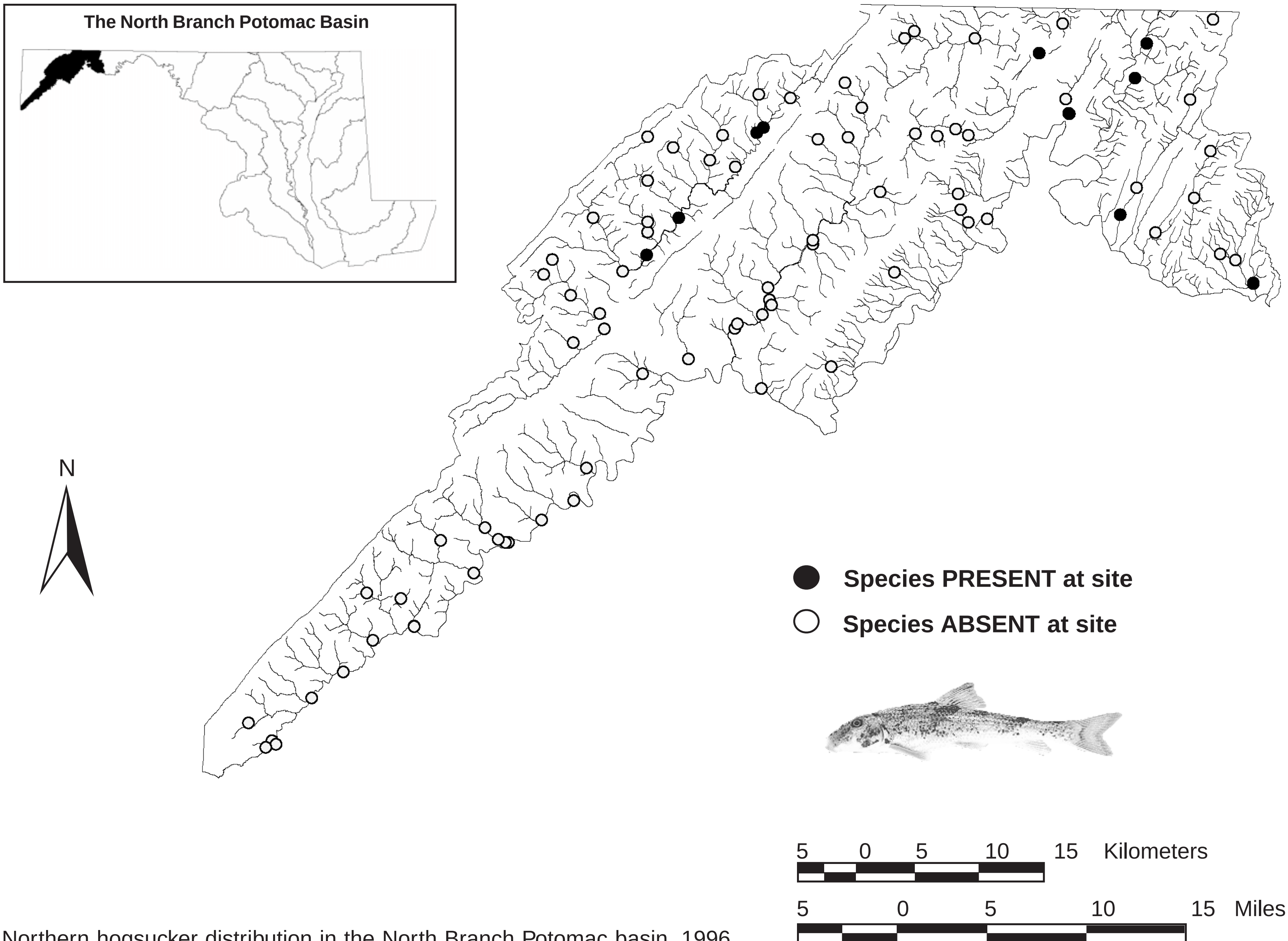


Creek chubsucker distribution in the North Branch Potomac basin, 1996.

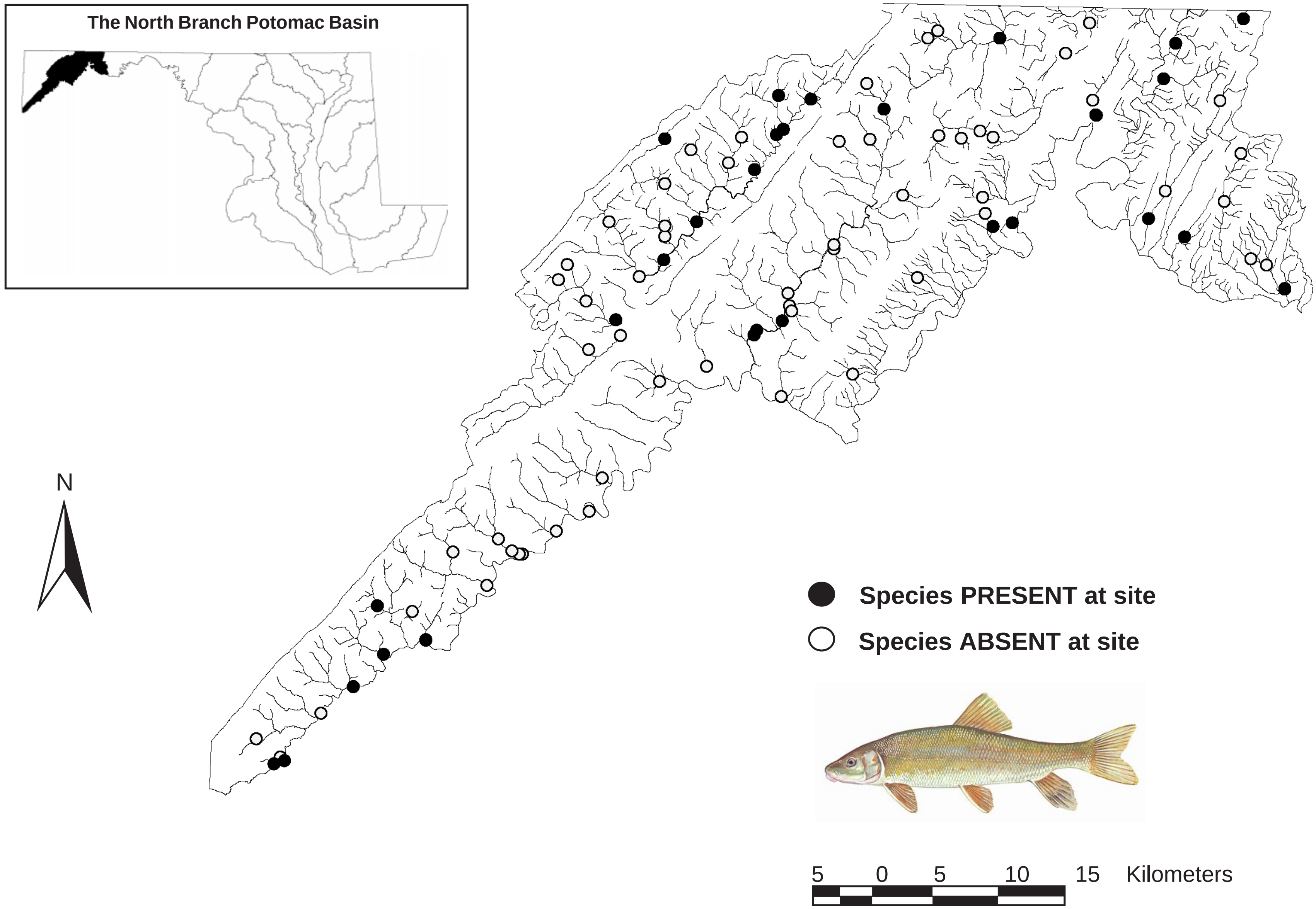




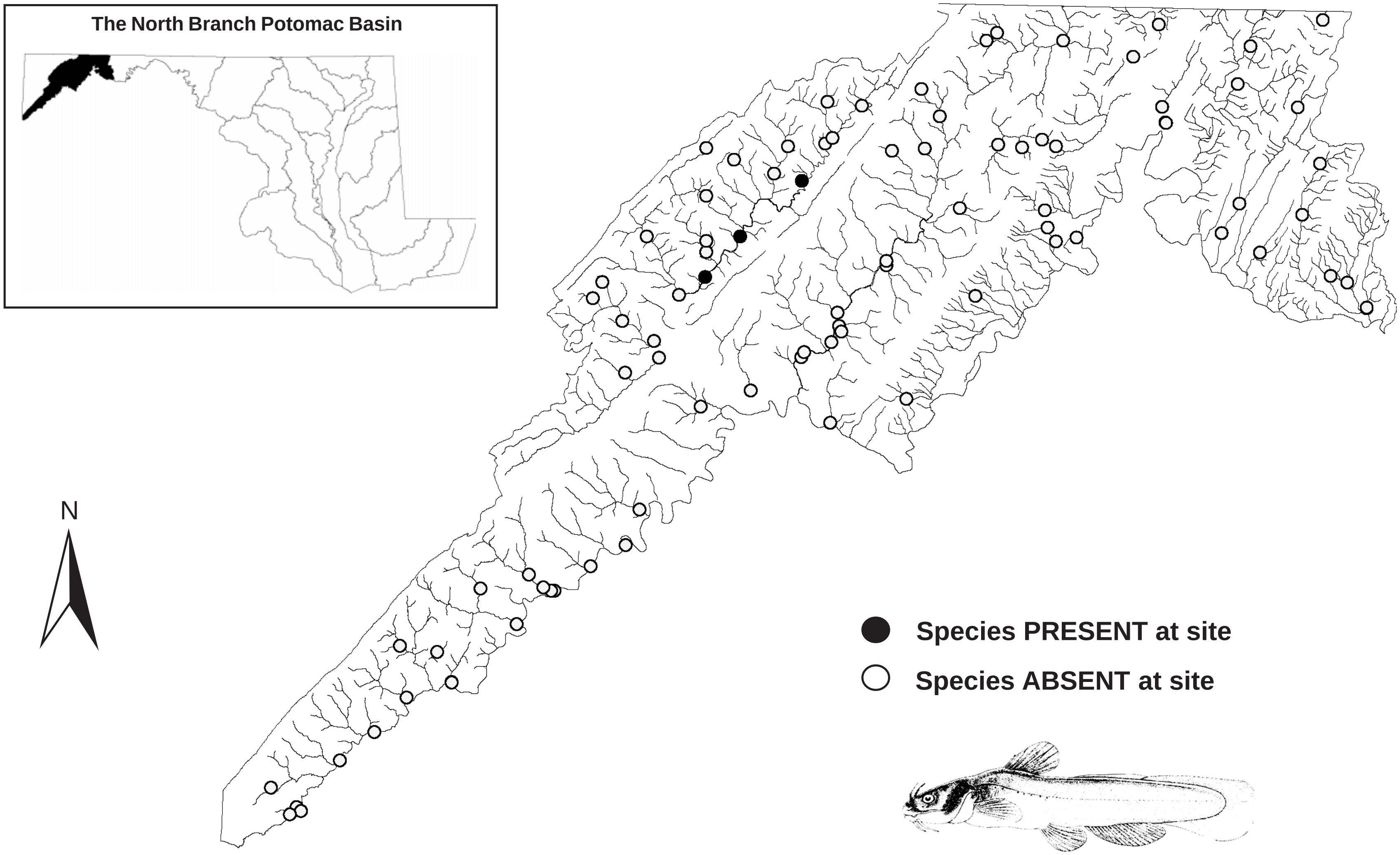
Golden redhorse distribution in the North Branch Potomac basin, 1996.

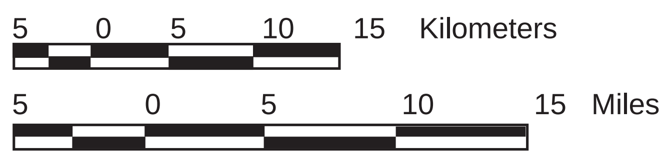


Northern hogsucker distribution in the North Branch Potomac basin, 1996.

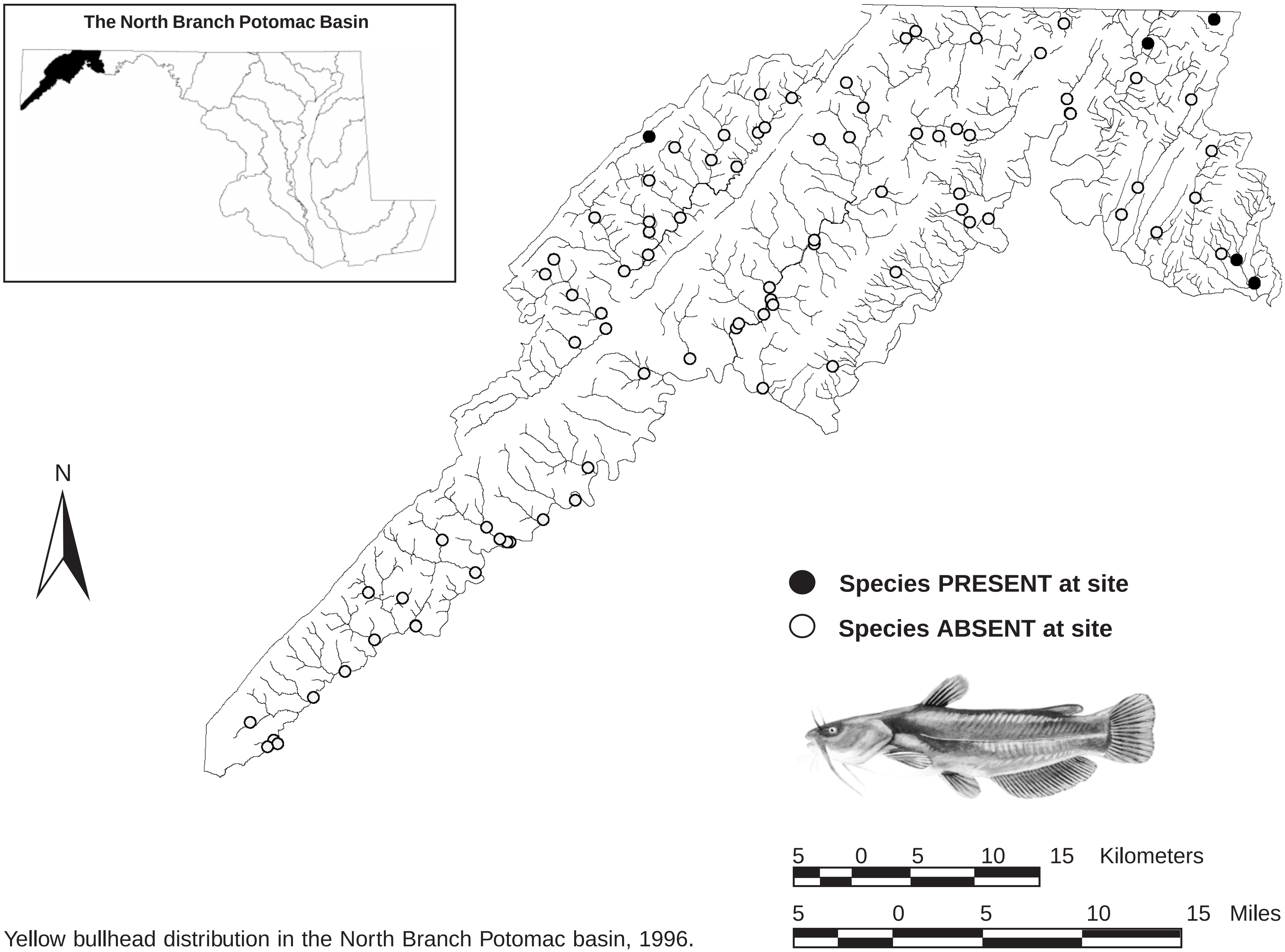


White sucker distribution in the North Branch Potomac basin, 1996.

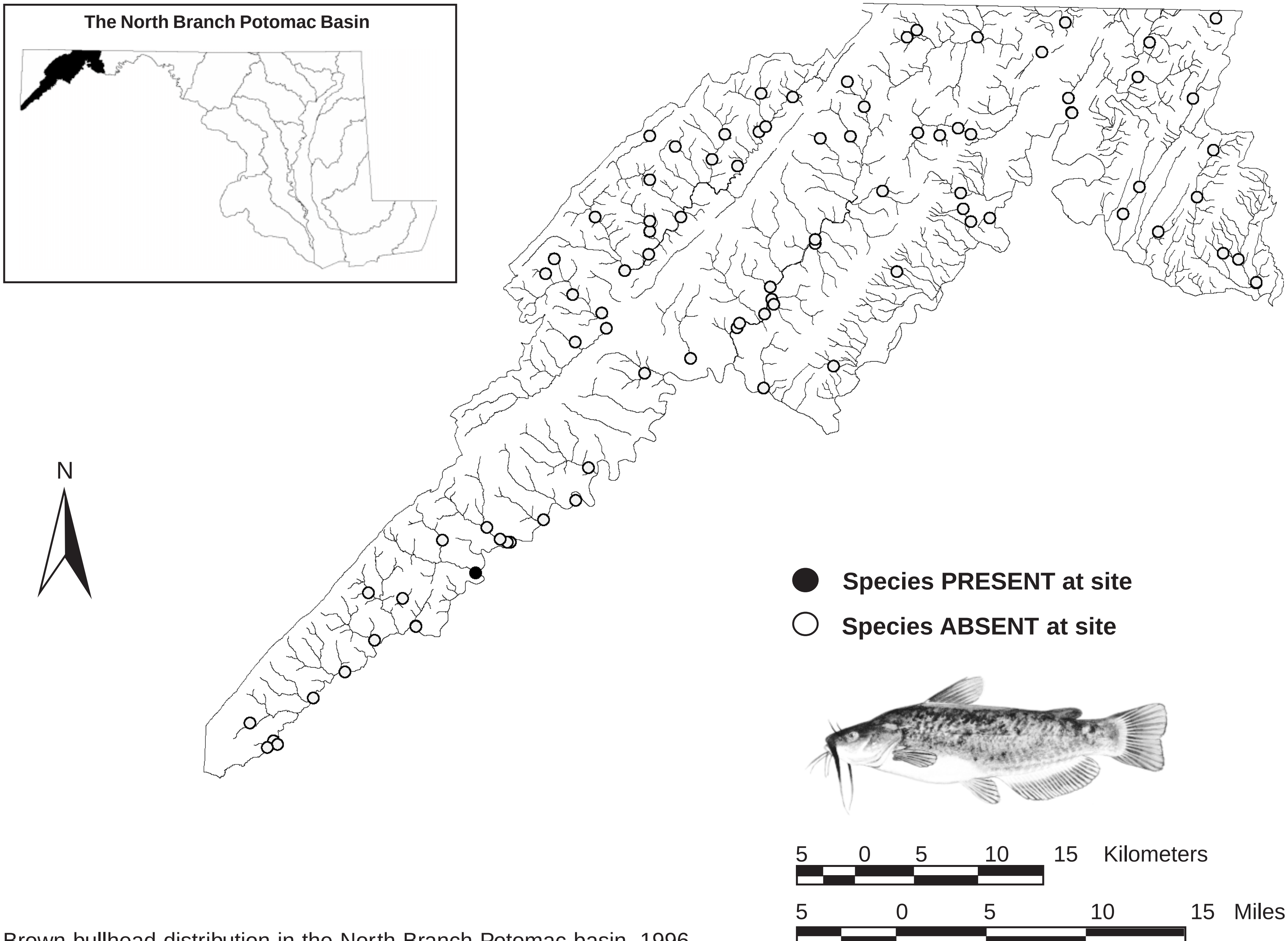




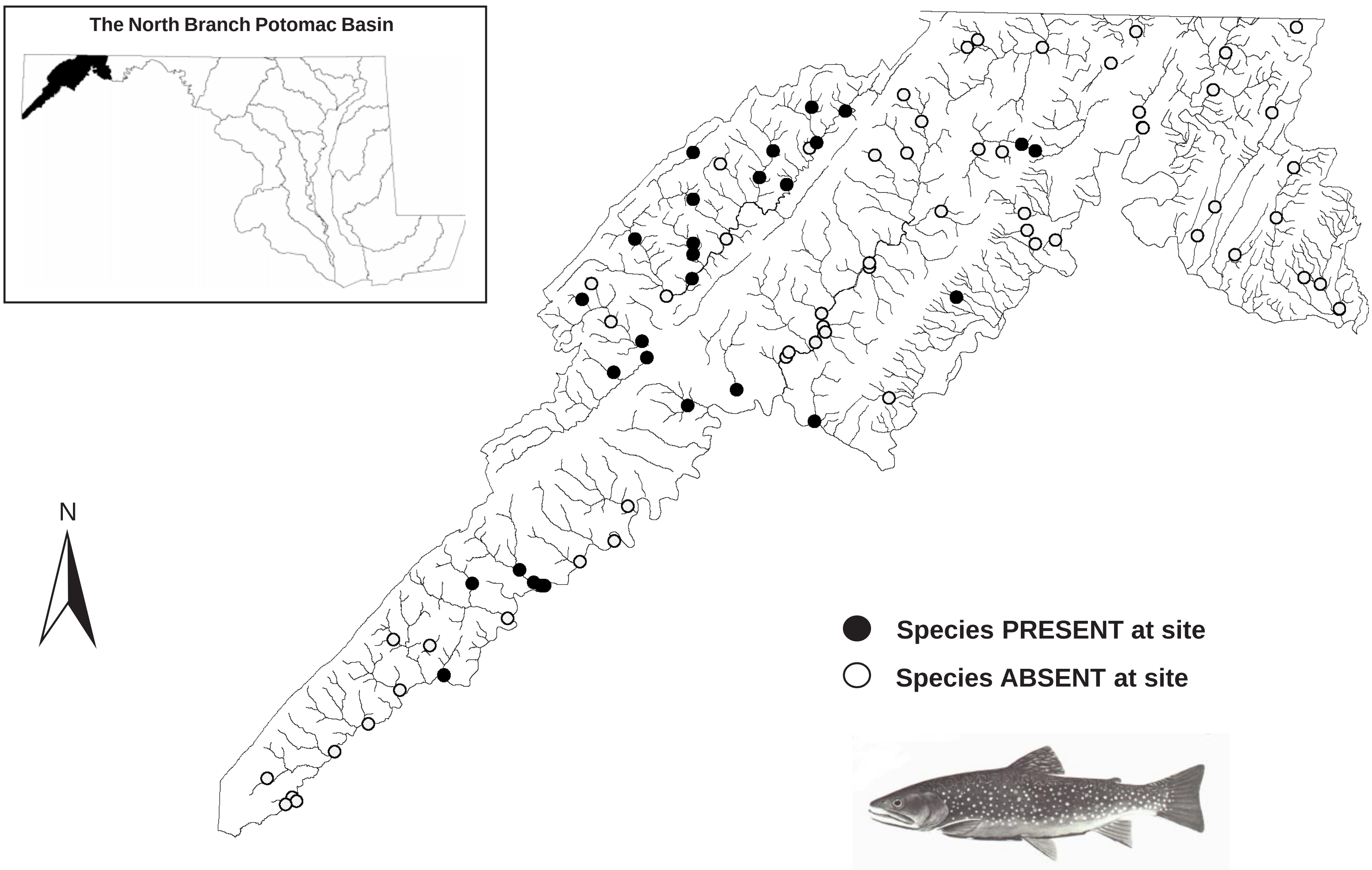
Margined madtom distribution in the North Branch Potomac basin, 1996.

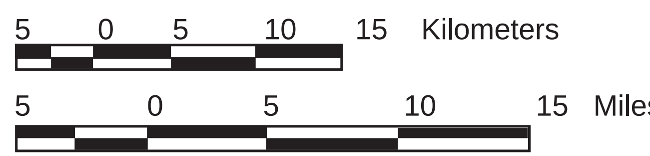


Yellow bullhead distribution in the North Branch Potomac basin, 1996.

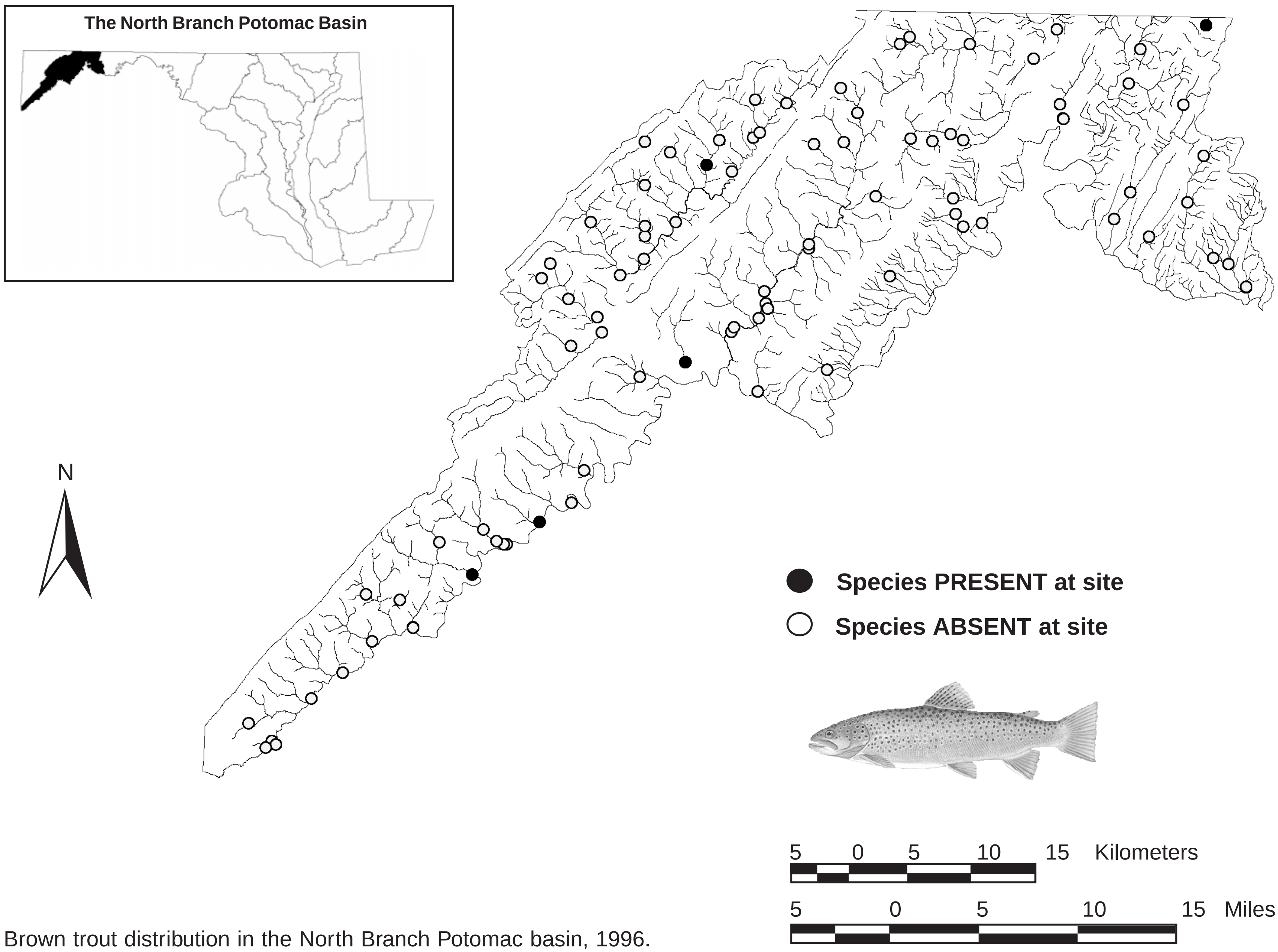


Brown bullhead distribution in the North Branch Potomac basin, 1996.

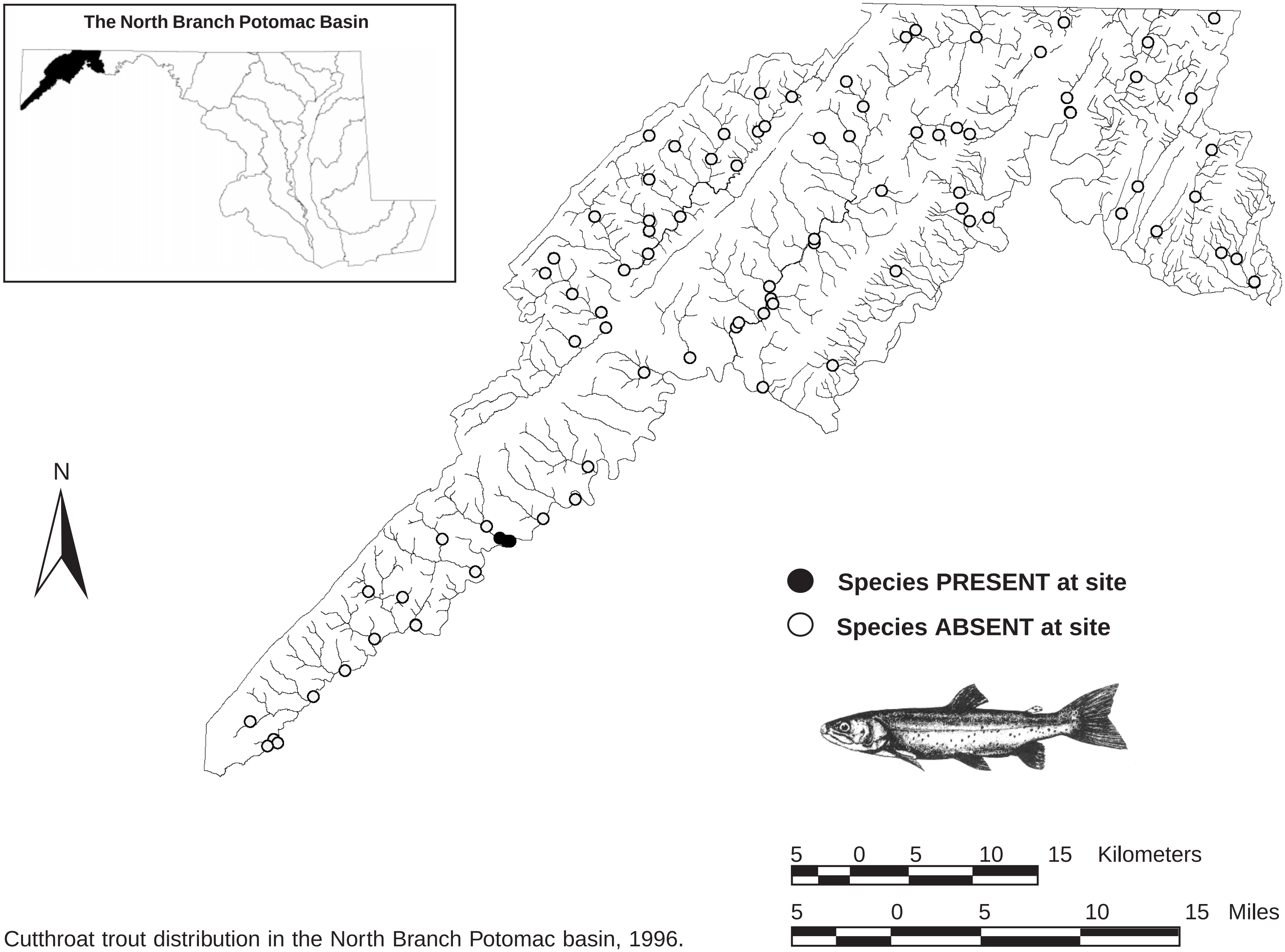




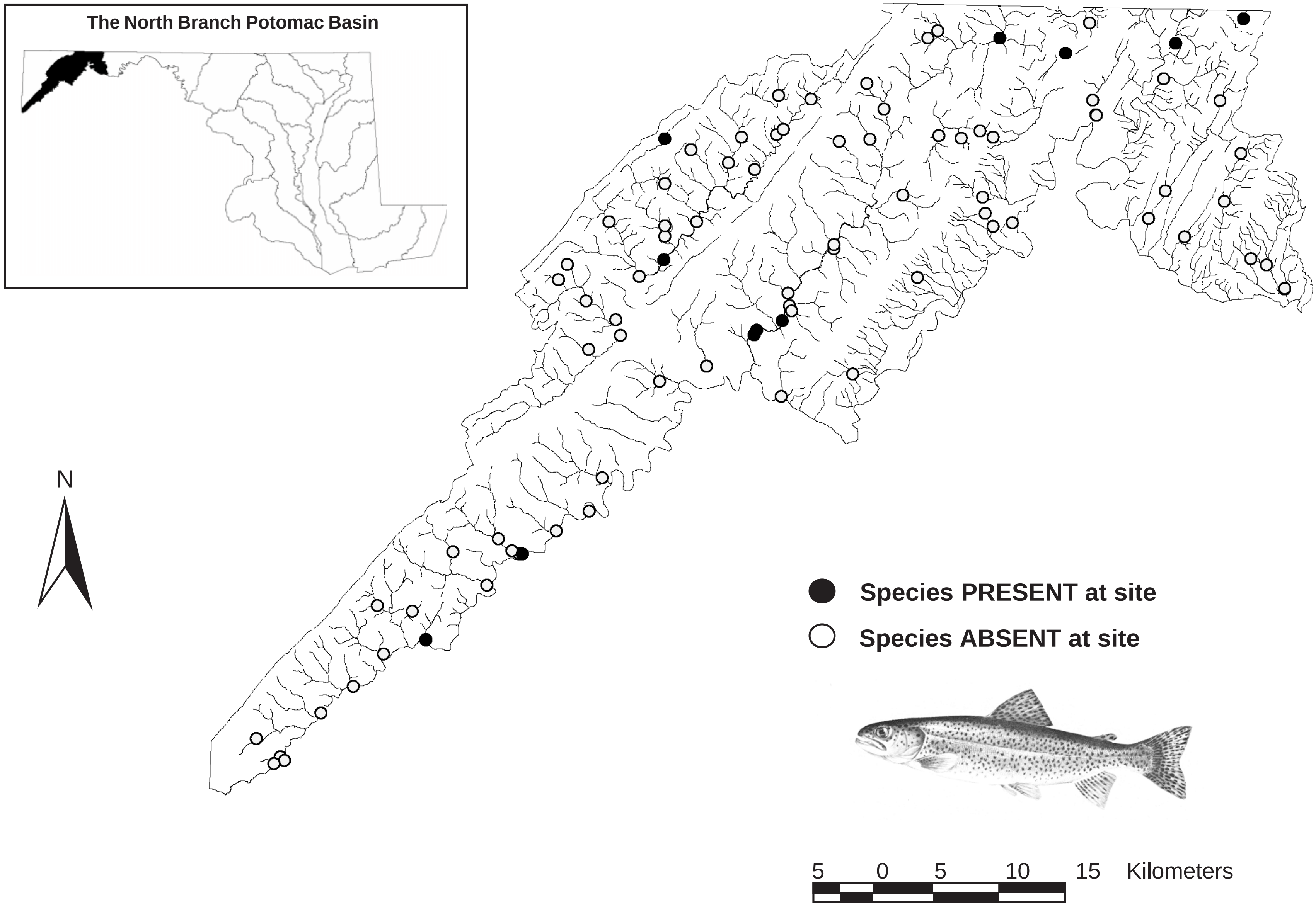
Brook trout distribution in the North Branch Potomac basin, 1996.



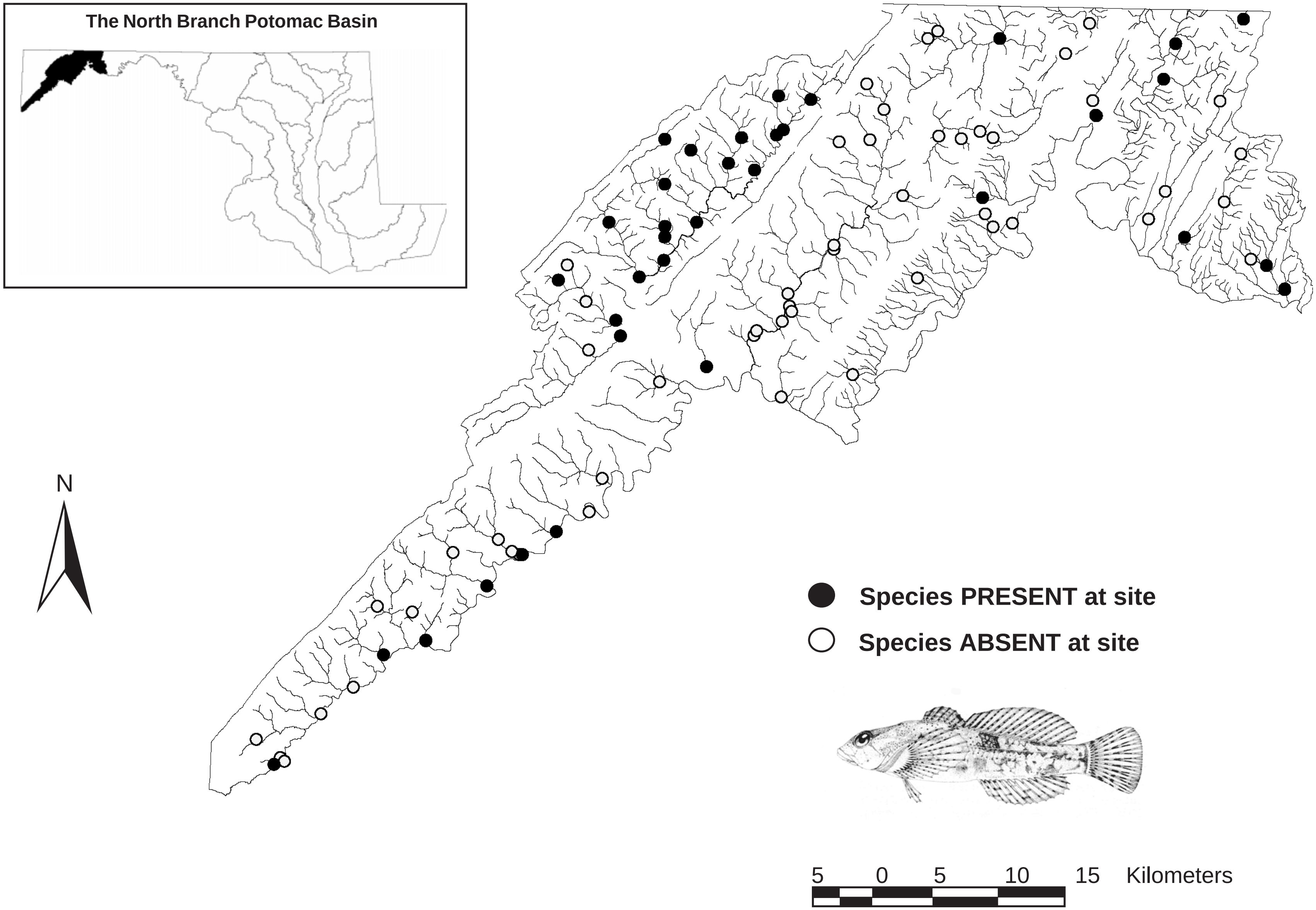
Brown trout distribution in the North Branch Potomac basin, 1996.



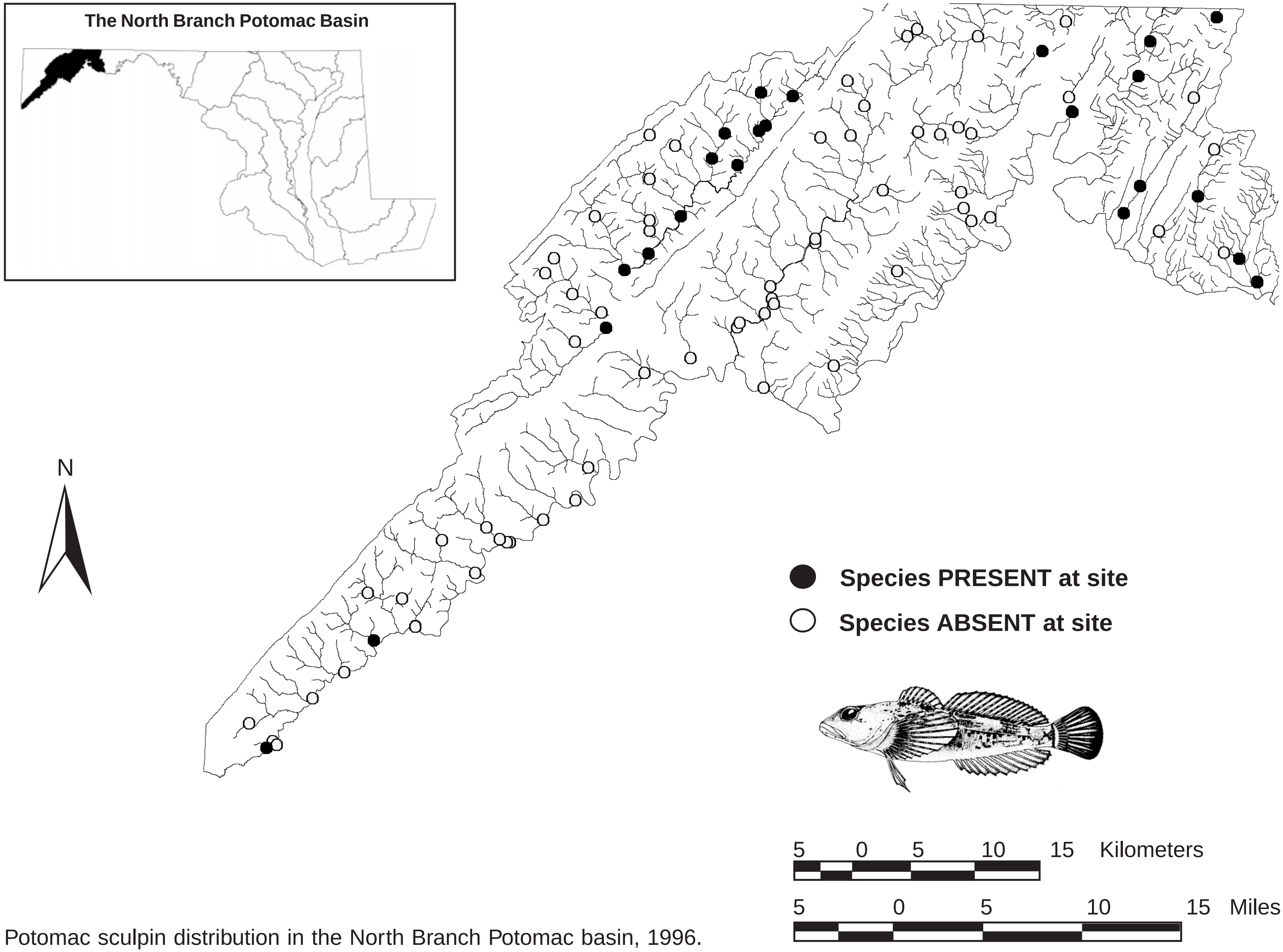
Cutthroat trout distribution in the North Branch Potomac basin, 1996.



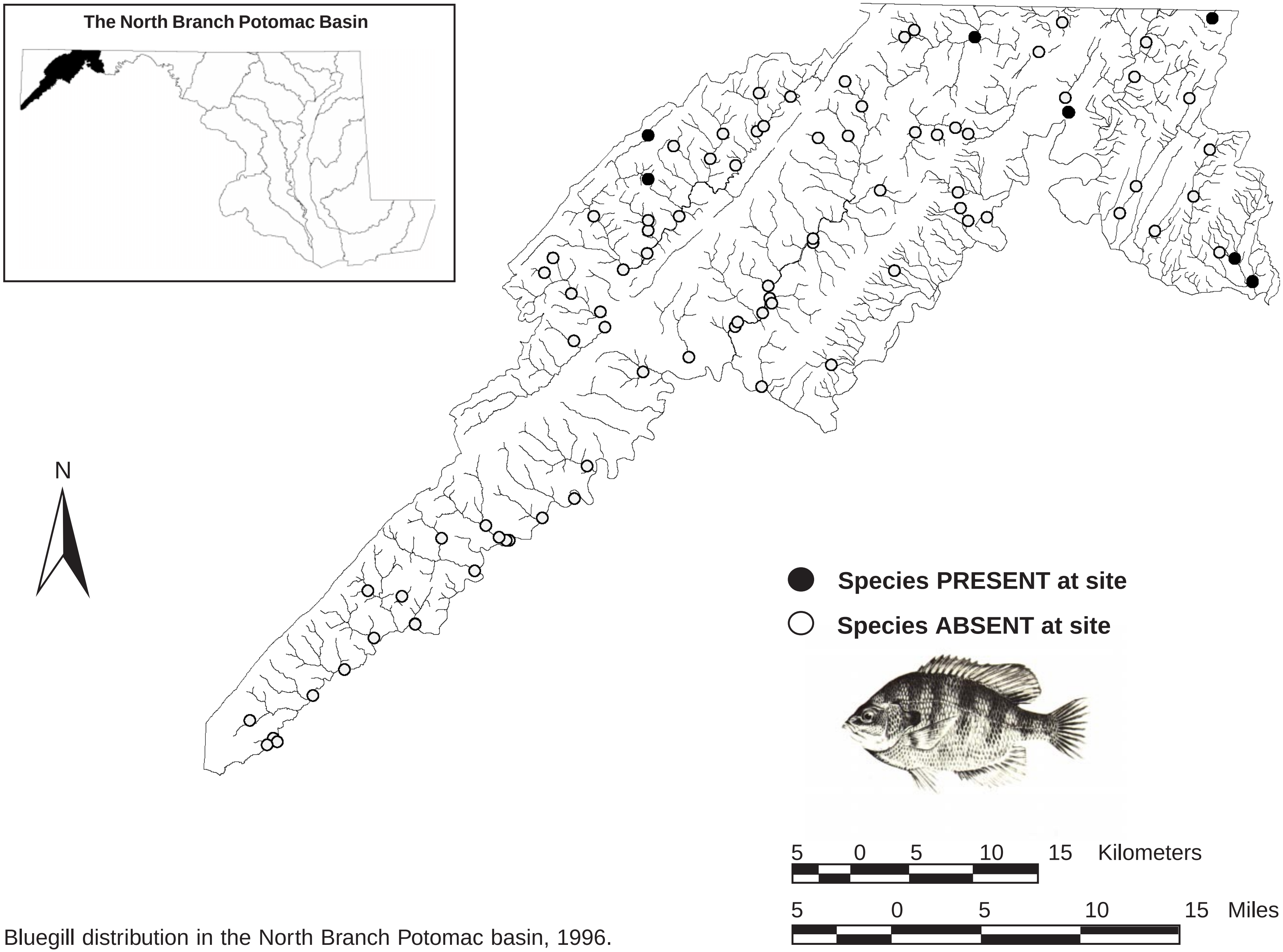
Rainbow trout distribution in the North Branch Potomac basin, 1996.



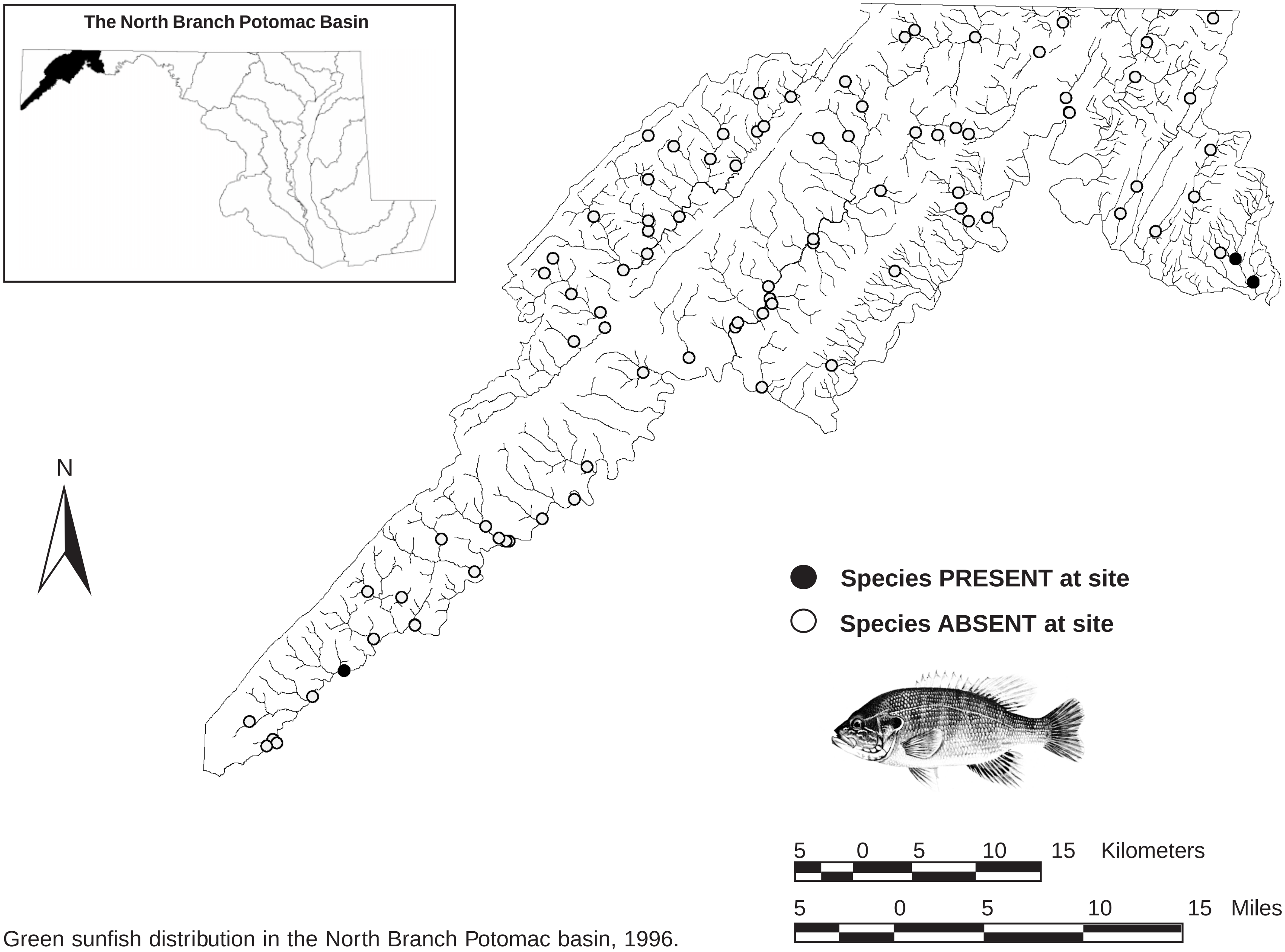
Mottled sculpin distribution in the North Branch Potomac basin, 1996.



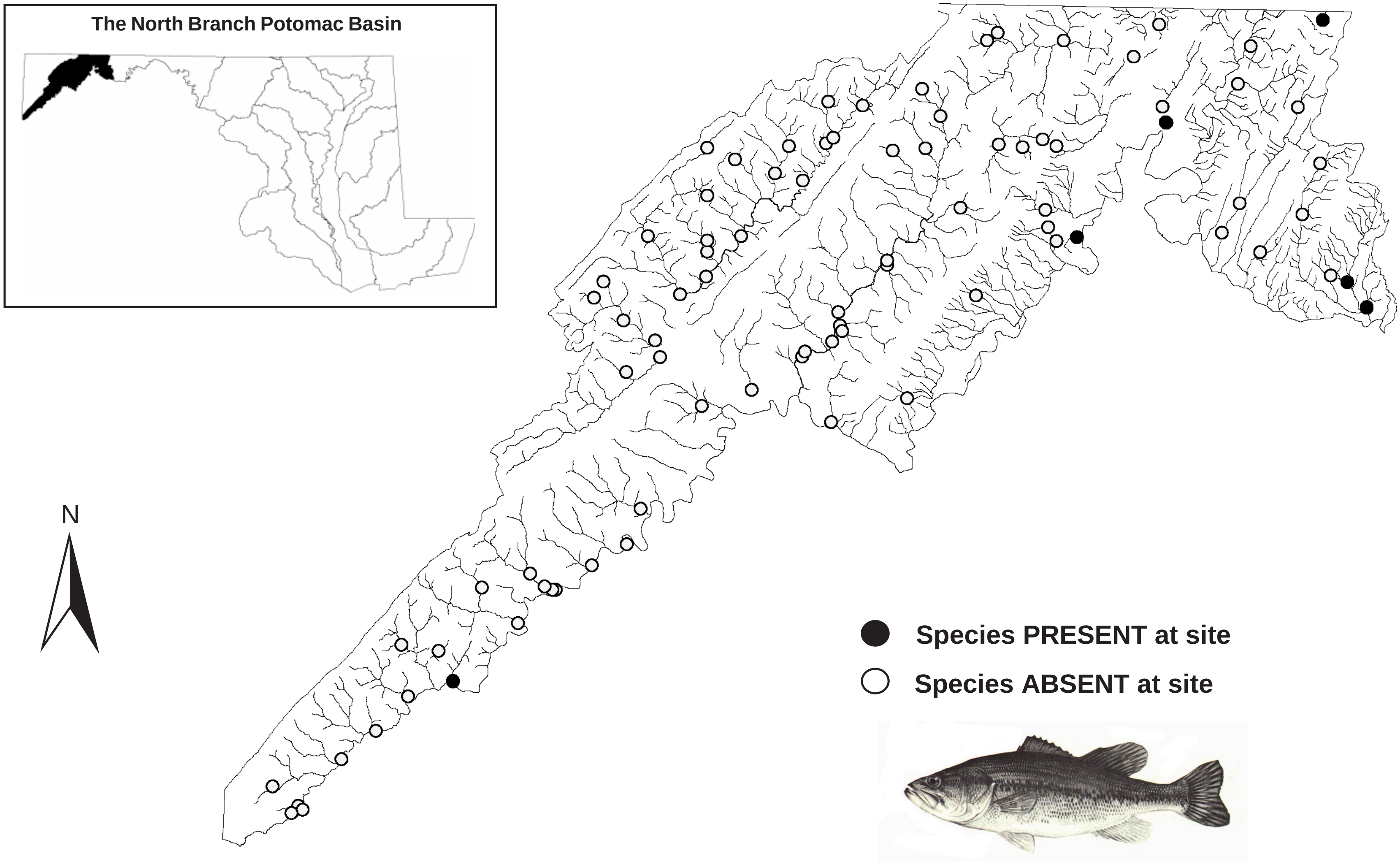
Potomac sculpin distribution in the North Branch Potomac basin, 1996.

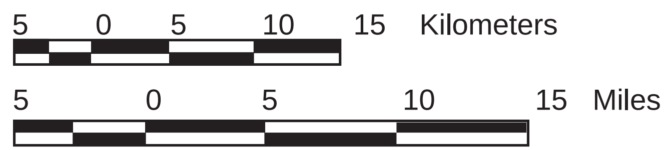


Bluegill distribution in the North Branch Potomac basin, 1996.

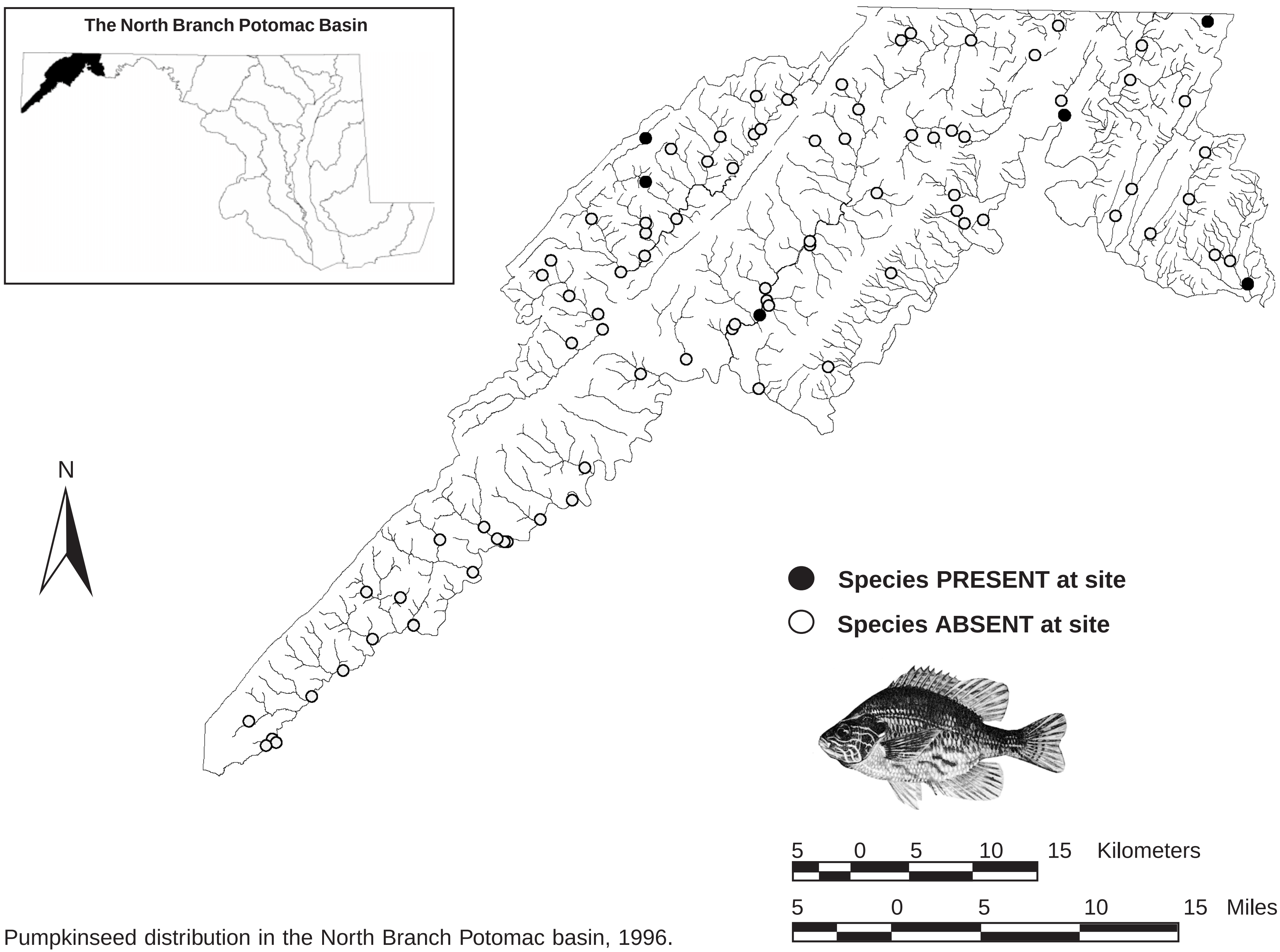


Green sunfish distribution in the North Branch Potomac basin, 1996.

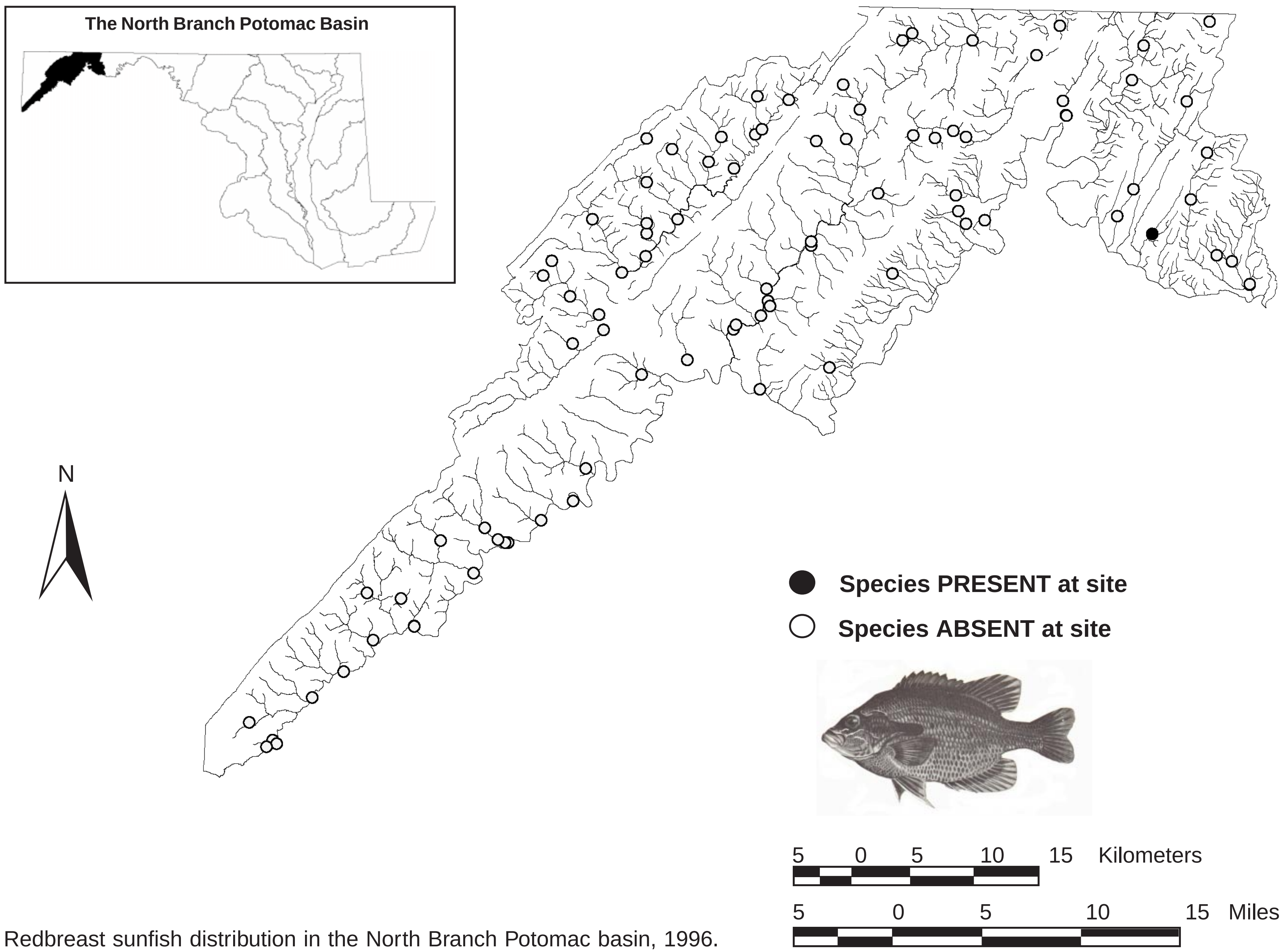




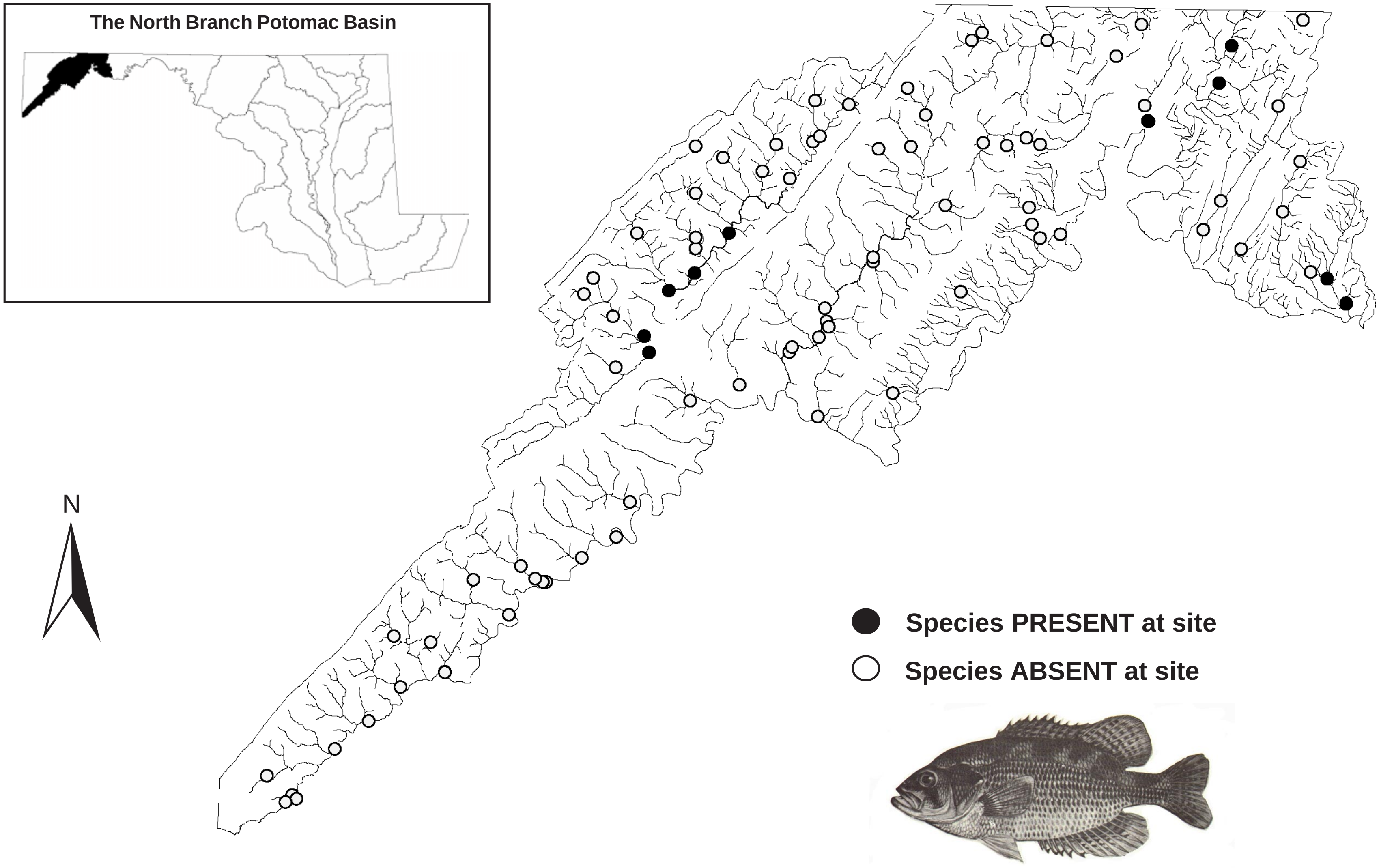
Largemouth bass distribution in the North Branch Potomac basin, 1996.

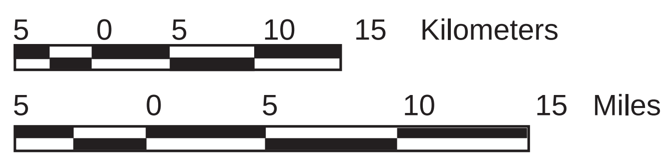


Pumpkinseed distribution in the North Branch Potomac basin, 1996.

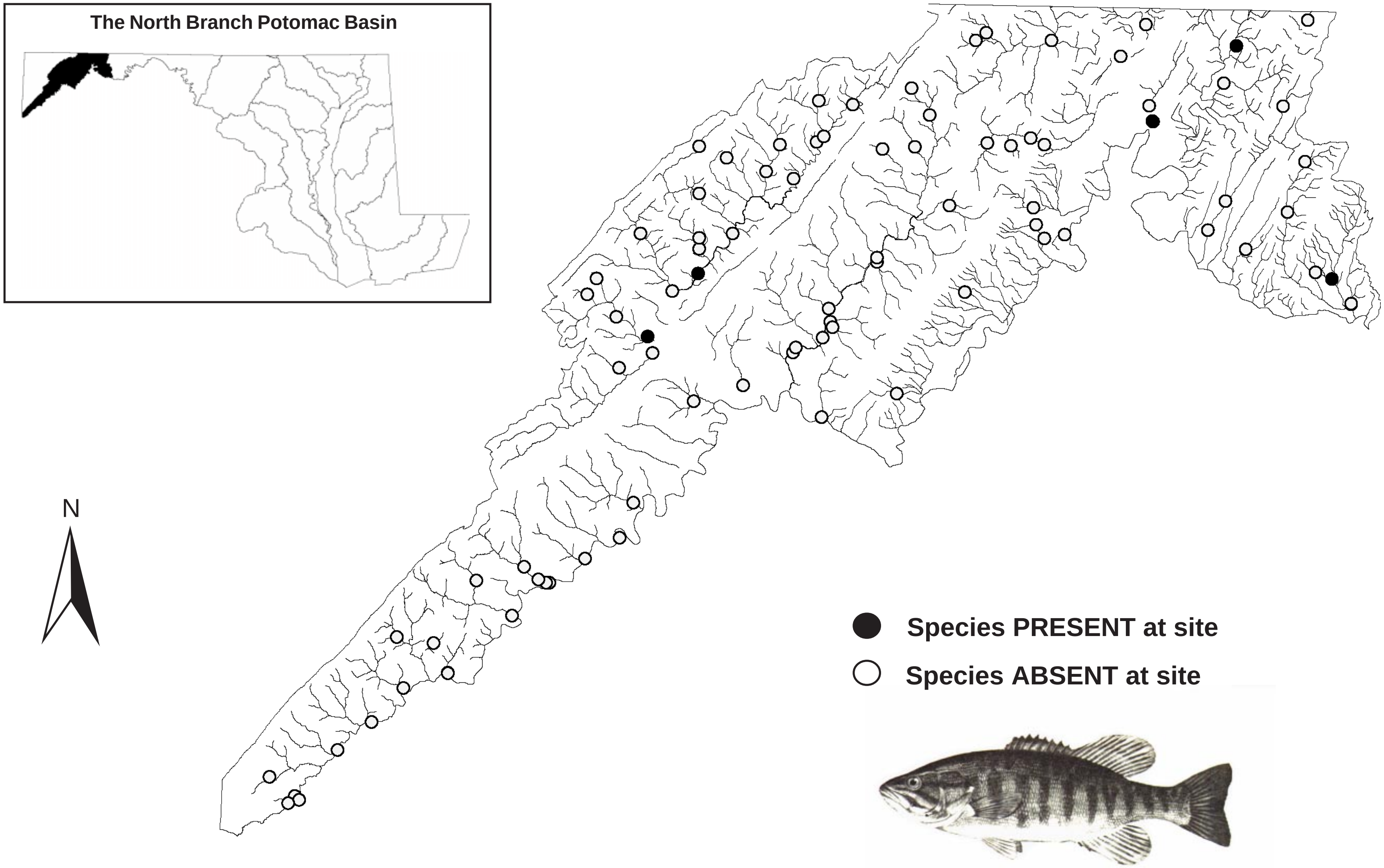


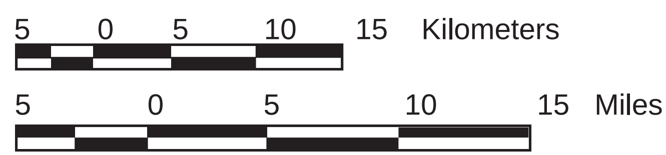
Redbreast sunfish distribution in the North Branch Potomac basin, 1996.



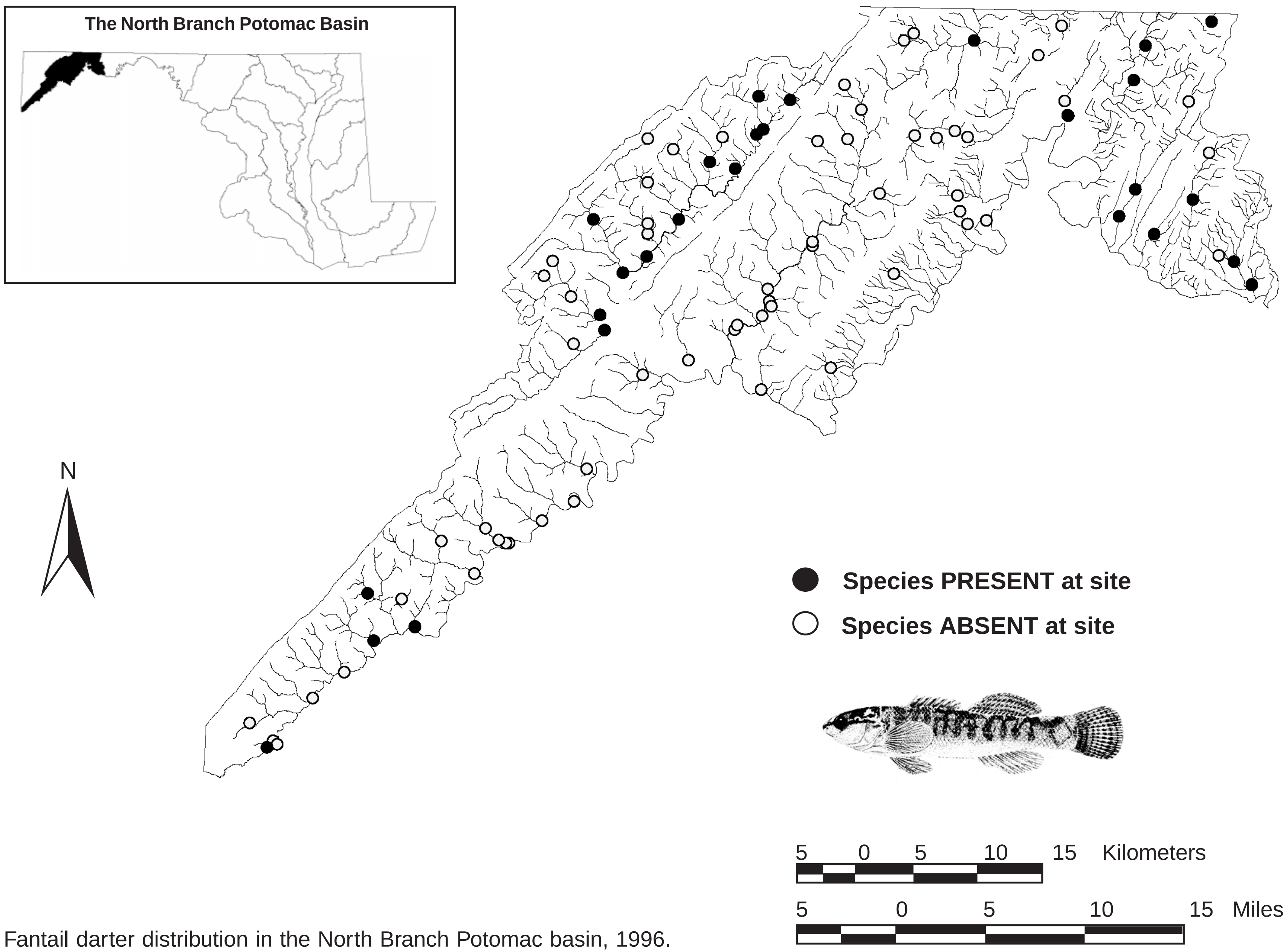


Rock bass distribution in the North Branch Potomac basin, 1996.

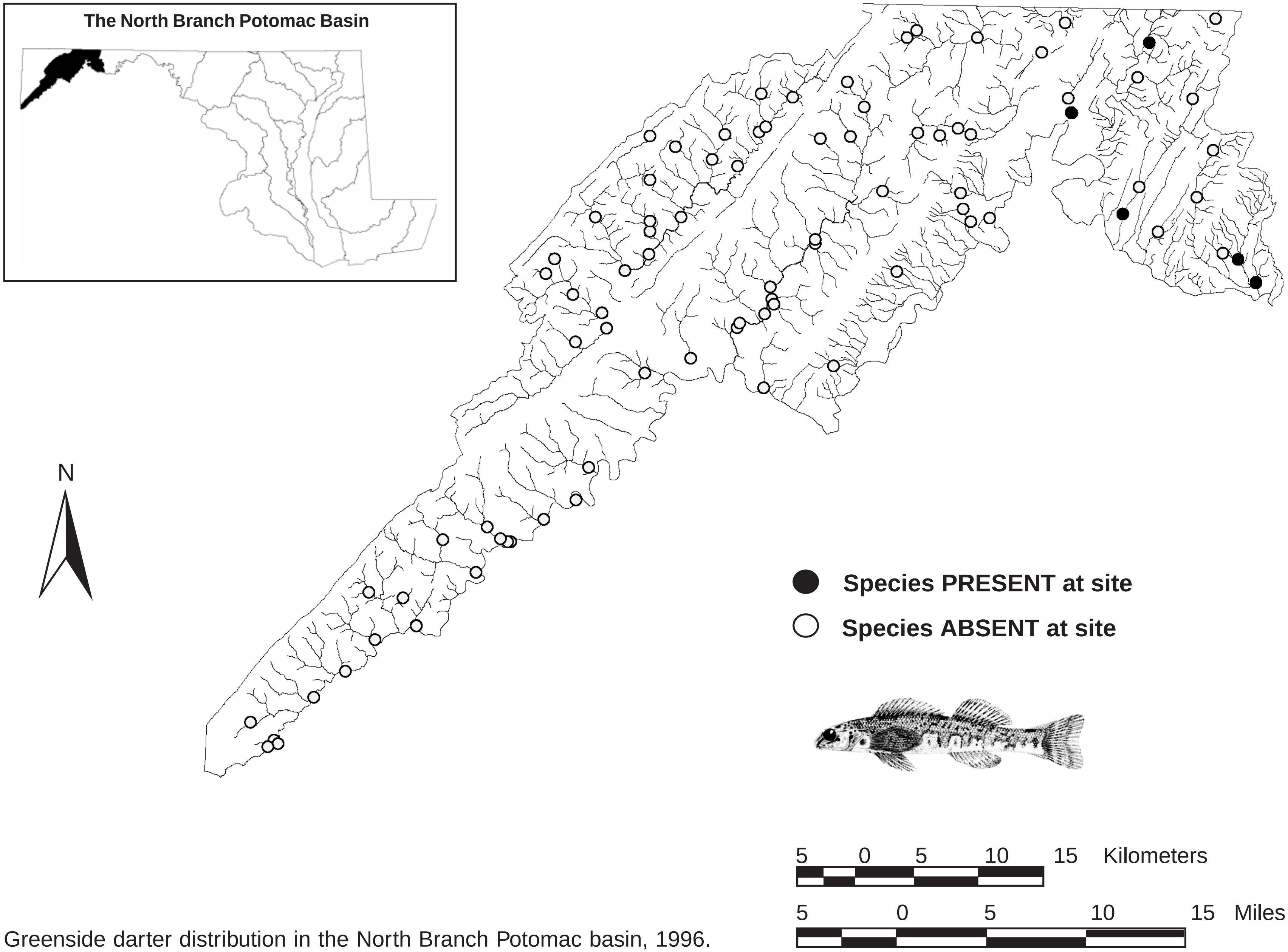




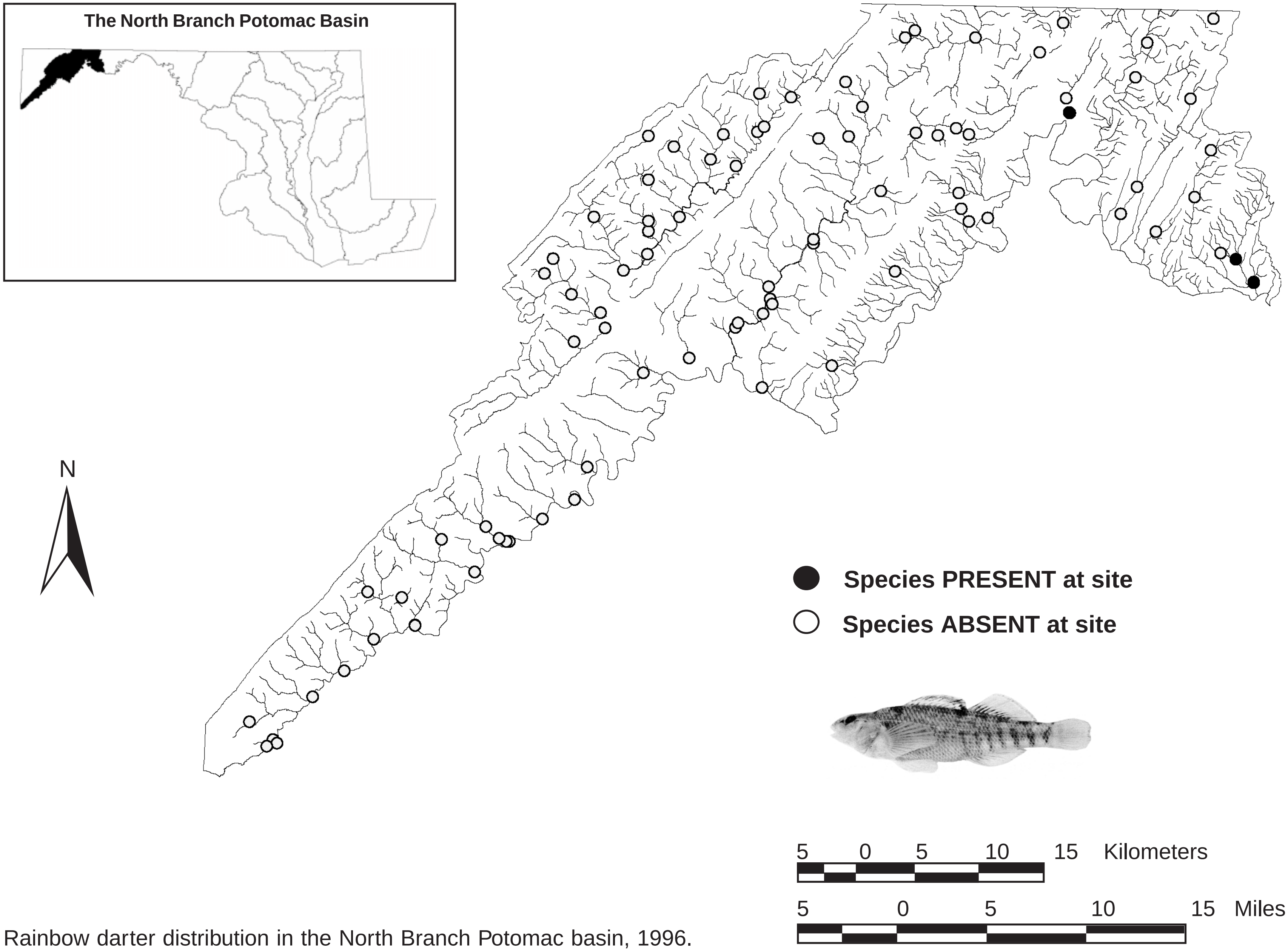
Smallmouth bass distribution in the North Branch Potomac basin, 1996.



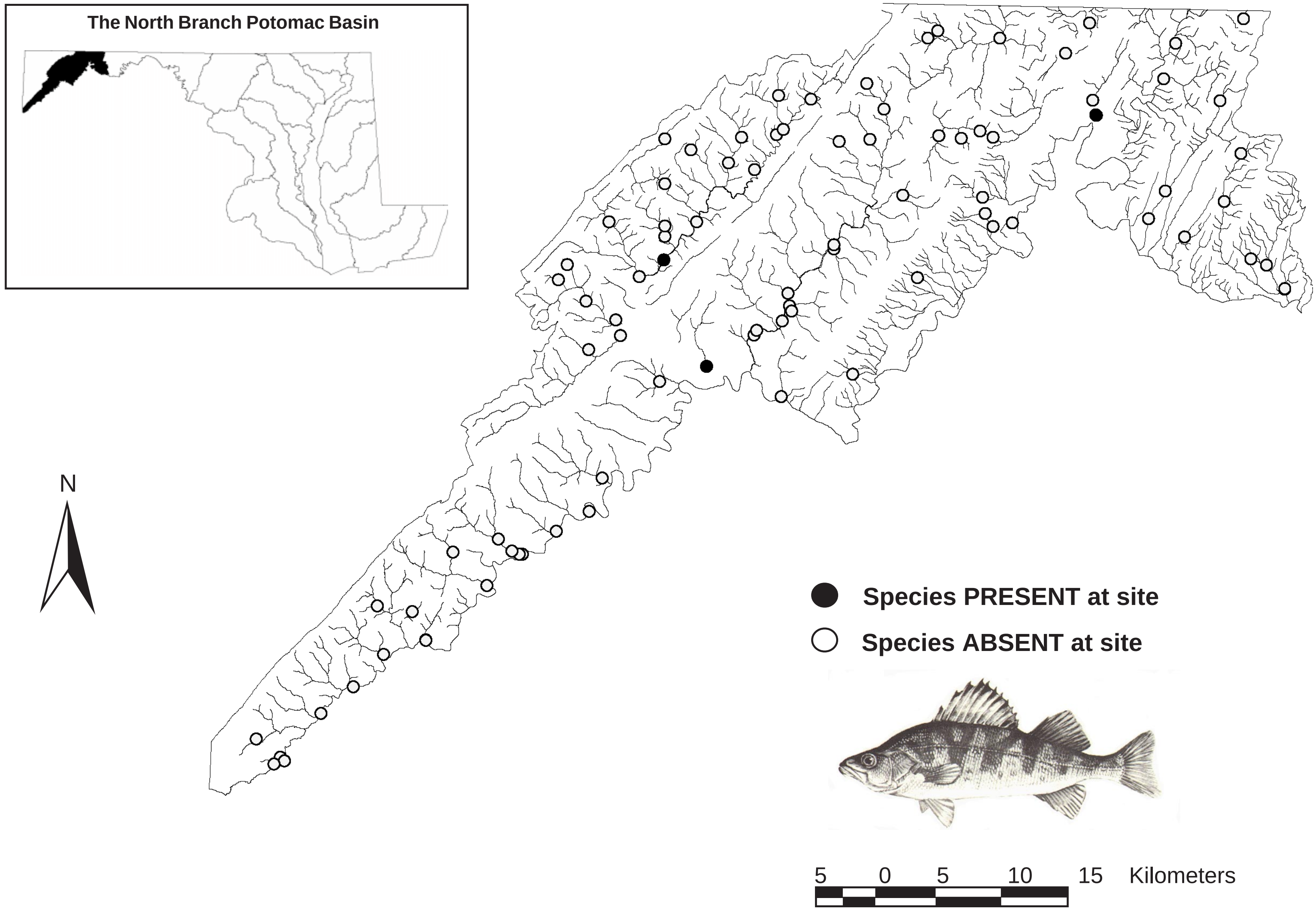
Fantail darter distribution in the North Branch Potomac basin, 1996.



Greenside darter distribution in the North Branch Potomac basin, 1996.



Rainbow darter distribution in the North Branch Potomac basin, 1996.



Yellow perch distribution in the North Branch Potomac basin, 1996.

Appendix F. Benthic macroinvertebrate taxa with designated tolerance value (TV 10 = most tolerant, 0 = least tolerant), functional feeding groups (FFG), habit, and percent occurrence (% Occ.) for the 1996 MBSS sites in the North Branch Potomac basin. Abbreviations of habits are as follows: bu - burrower, cn - clinger, sp - spawler, cb - climber, sw -swimmer, dv - diver, sk - skater (modified from Stribling et al. 1998)

Class	*Order*	*Family*	*Genus*	*TV*	*FFG*	*Habit*	*% Occ.*
Oligochaeta	Lumbriculida	Lumbriculidae		10	Collector	bu	10.9
	Tubificida	Enchytraeidae		10	Collector	bu	7.8
		Naididae		10	Collector	bu	1.6
		Tubificidae	*Limnodrilus*	10	Collector	cn	1.6
Gastropoda	Basommatophora	Physidae	*Physella*	8	Scraper	cb	1.6
		Planorbidae	*Gyraulus*	8	Scraper	cb	1.6
Pelecypoda	Veneroida	Corbiculidae	*Corbicula*	6	Filterer	bu	1.6
Malacostraca	Amphipoda	Crangonyctidae	*Crangonyx*	4	Collector	sp	4.7
		Gammaridae	*Gammarus*	6	Shredder	sp	15.6
	Isopoda	Asellidae	*Caecidotea*	8	Collector	sp	17.2
Insecta	Ephemeroptera	Ameletidae	*Ameletus*	0	Collector	sw, cb	35.9
		Baetidae	*Acentrella*	4	Collector	sw, cn	1.6
			Acerpenna	4	Collector	sw, cn	14.1
			Baetis	6	Collector	sw, cb, cn	15.6
			Barbaetis	10	Collector		1.6
			Diphetor		Collector	sw, cn	3.1
		Caenidae	*Caenis*	7	Collector	sp	1.6
		Ephemerellidae	*Drunella*	1	Scraper	cn, sp	6.3
			Ephemerella	2	Collector	cn, sw	65.6
			Eurylophella	4	Scraper	cn, sp	7.8
			Serratella	2	Collector	cn	1.6
			Timpanoga	2	Collector	sp	1.6
		Ephemeridae	*Ephemera*	3	Collector	bu	1.6
			Hexagenia	6	Collector	bu	1.6
		Heptageniidae	*Cinygmula*		Scraper	cn	31.3
			Epeorus	0	Scraper	cn	46.9
			Heptagenia	4	Scraper	cn, sw	4.7
			Stenacron	4	Collector	cn	4.7
			Stenonema	4	Scraper	cn	21.9
		Isonychiidae	*Isonychia*	2	Filterer	sw, cn	9.4
		Leptophlebiidae	*Paraleptophlebia*	2	Collector	sw, cn, sp	42.2
		Cordulegastridae	*Cordulegaster*	3	Predator	bu	1.6
		Gomphidae	*Lanthus*	6	Predator	bu	4.7
Insecta	Plecoptera	Capniidae	*Allocapnia*	3	Shredder	cn	3.1
			Paracapnia	1	Shredder		7.8
		Chloroperlidae	*Haploperla*		Predator	cn	1.6
			Sweltsa		Predator	cn	34.4
		Leuctridae	*Leuctra*	0	Shredder	cn	56.3
		Nemouridae	*Amphinemura*	3	Shredder	sp, cn	70.3
			Ostrocerca		Shredder	sp, cn	31.3
			Prostoia		Shredder	sp, cn	4.7
		Peltoperlidae	*Peltoperla*		Shredder	cn, sp	7.8
			Tallaperla		Shredder	cn, sp	4.7
		Perlidae	*Acroneuria*	0	Predator	cn	31.3
			Eccoptura		Predator	cn	1.6

Class	Order	Family	Genus	TV	FFG	Habit	% Occ.
Insecta	Plecoptera	Perlidae	*Neoperla*	3	Predator	cn	1.6
		Perlodidae	*Clioperla*	1	Predator	cn	3.1
			Isoperla	2	Predator	cn, sp	40.6
		Pteronarcyidae	*Pteronarcys*	2	Shredder	cn, sp	23.4
		Taeniopterygidae	*Oemopteryx*		Shredder	sp, cn	7.8
			Strophopteryx		Shredder	sp, cn	3.1
Insecta	Megaloptera	Corydalidae	*Nigronia*	0	Predator	cn, cb	4.7
		Sialidae	*Sialis*	4	Predator	bu, cb, cn	1.6
Insecta	Trichoptera	Brachycentridae	*Brachycentrus*	1	Filterer	cn	1.6
			Micrasema	2	Shredder	cn, sp	4.7
		Dipseudopsidae	*Phylocentropus*	5	Collector	bu	1.6
		Glossosomatidae	*Agapetus*	2	Scraper	cn	1.6
		Hydropsychidae	*Cheumatopsyche*	5	Filterer	cn	29.7
			Diplectrona	2	Filterer	cn	50.0
			Hydropsyche	6	Filterer	cn	28.1
		Hydroptilidae	*Hydroptila*	6	Scraper	cn	1.6
		Lepidostomatidae	*Lepidostoma*	3	Shredder	cb, sp, cn	6.3
			Pycnopsyche	4	Shredder	sp, cb, cn	1.6
		Odontoceridae	*Psilotreta*	0	Scraper	sp	1.6
		Philopotamidae	*Chimarra*	4	Filterer	cn	9.4
			Dolophilodes	0	Filterer	cn	14.1
			Wormaldia		Filterer	cn	21.9
			Polycentropus	5	Filterer	cn	1.6
		Rhyacophilidae	*Rhyacophila*	1	Predator	cn	51.6
		Uenoidae	*Neophylax*	3	Scraper	cn	39.1
Insecta	Lepidoptera	Pyralidae			Shredder	cb	1.6
Insecta	Coleoptera	Elmidae	*Dubiraphia*	6	Scraper	cn, cb	1.6
			Optioservus	4	Scraper	cn	10.9
			Oulimnius	2	Scraper	cn	4.7
			Stenelmis	6	Scraper	cn	1.6
		Psephenidae	*Ectopria*	5	Scraper	cn	4.7
		Ptilodactylidae	*Anchytarsus*	4	Shredder	cn	6.3
Insecta	Diptera	Athericidae	*Atherix*	2	Predator	sp, bu	3.1
		Blephariceridae	*Blepharicera*		Scraper	cn	3.1
			Bezzia	6	Predator	bu	9.4
			Ceratopogon	6	Predator	sp, bu	3.1
			Culicoides	10	Predator	bu	1.6
		Chaoboridae	*Chaoborus*		Predator	sp, sw	1.6
		Chironomidae	*Brillia*	5	Shredder	bu, sp	6.3
			Cardiocladius	6	Predator	bu, cn	1.6
			Chaetocladius	6	Collector	sp	1.6
			Conchapelopia	6	Predator	sp	14.1
			Corynoneura	7	Collector	sp	3.1
			Cricotopus	7	Shredder	cn, bu	1.6
			Cricotopus/ Orthocladius		Shredder		17.2
			Diamesinae	5	Collector	sp	1.6
			Diamesa	5	Collector	sp	29.7
			Eukiefferiella	8	Collector	sp	39.1

Class	Order	Family	Genus	TV	FFG	Habit	% Occ.
Insecta	Diptera	Chironomidae	*Heleniella*		Predator	sp	1.6
			Heterotrissocladius		Collector	sp, bu	1.6
			Larsia	6	Predator	sp	6.3
			Micropsectra	7	Collector	cb, sp	17.2
			Microtendipes	6	Filterer	cn	3.1
			Nanocladius	3	Collector	sp	1.6
			Orthocladius	6	Collector	sp, bu	12.5
			Parachaetocladius	2	Collector	sp	1.6
			Parakiefferiella	4	Collector	sp	1.6
			Paramerina	4	Predator	sp	1.6
			Parametriocnemus	5	Collector	sp	56.3
			Paraphaenocladius	4	Collector	sp	4.7
			Paratanytarsus	6	Collector	sp	1.6
			Polypedilum	6	Shredder	cb, cn	31.3
			Potthastia	2	Collector	sp	1.6
			Psectrocladius	8	Shredder	sp, bu	1.6
			Pseudorthocladius	0	Collector	sp	1.6
			Rheocricotopus	6	Collector	sp	1.6
			Stempellinella	4	Collector	cb, sp, cn	3.1
			Symposiocladius		Predator	sp	1.6
			Sympotthastia	2	Collector	sp	3.1
			Tanytarsus	6	Filterer	cb, cn	39.1
			Thienemanniella	6	Collector	sp	1.6
			Thienemannimyia		Predator	sp	6.3
			Trissopelopia		Predator	sp	1.6
			Tvetenia	5	Collector	sp	6.3
			Zavrelimyia	8	Predator	sp	4.7
		Empididae	*Clinocera*		Predator	cn	1.6
			Hemerodromia	6	Predator	sp, bu	1.6
		Simuliidae	*Prosimulium*	7	Filterer	cn	68.8
			Simulium	7	Filterer	cn	9.4
			Stegopterna	7	Filterer	cn	25.0
		Tabanidae	*Chrysops*	7	Predator	sp, bu	1.6
		Tipulidae	*Antocha*	5	Collector	cn	12.5
			Cryptolabis			bu	1.6
			Dicranota	4	Predator	sp, bu	18.8
			Hexatoma	4	Predator	bu, sp	39.1
			Ormosia		Collector	bu	6.3
			Pseudolimnophila	2	Predator	bu	4.7
			Tipula	4	Shredder	bu	15.6